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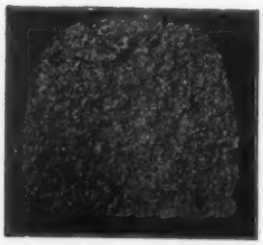

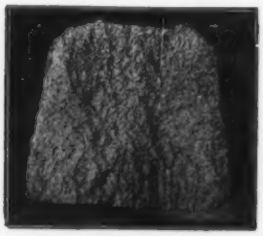

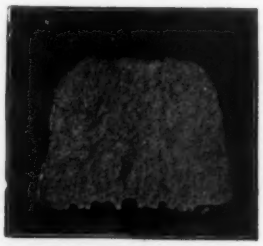

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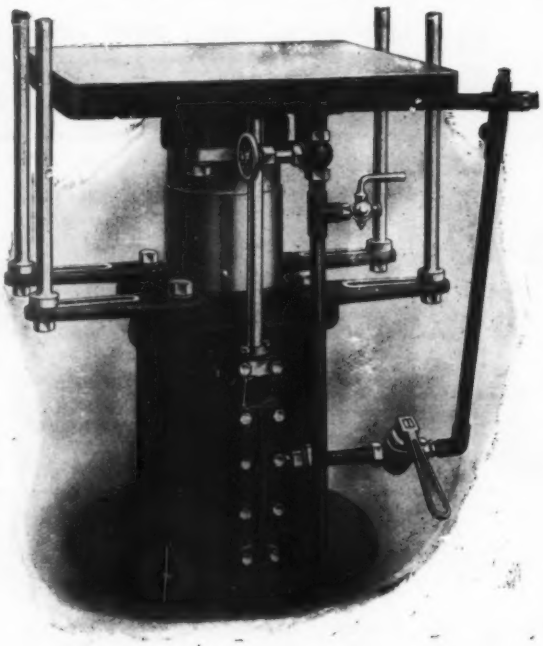

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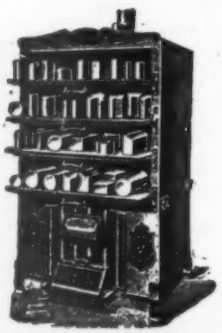

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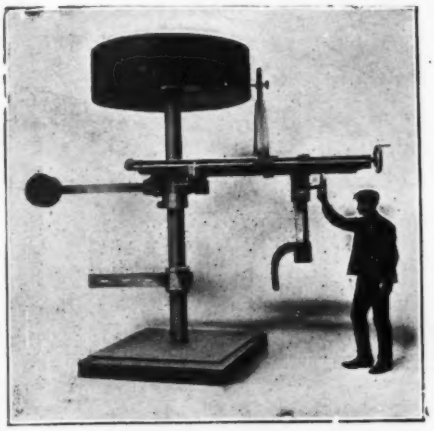

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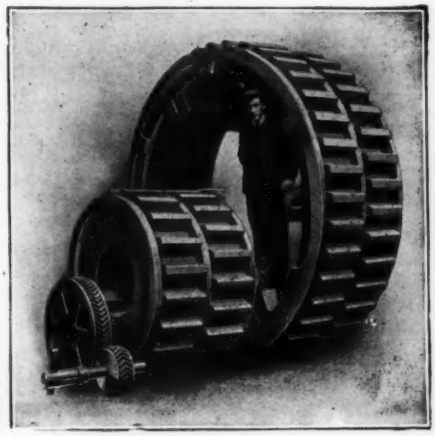

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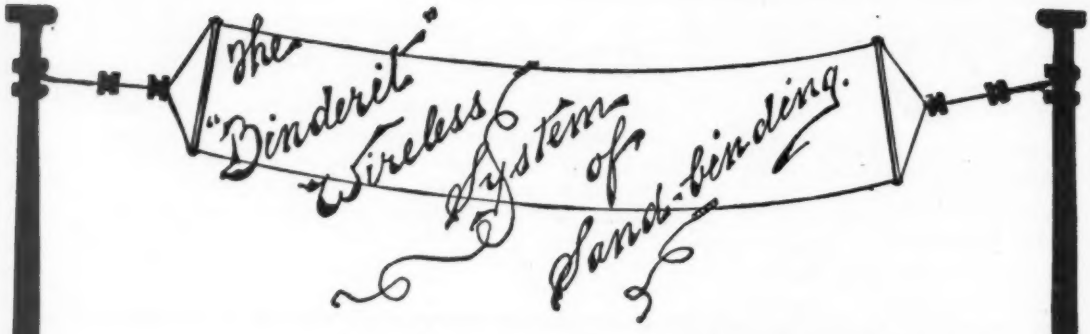

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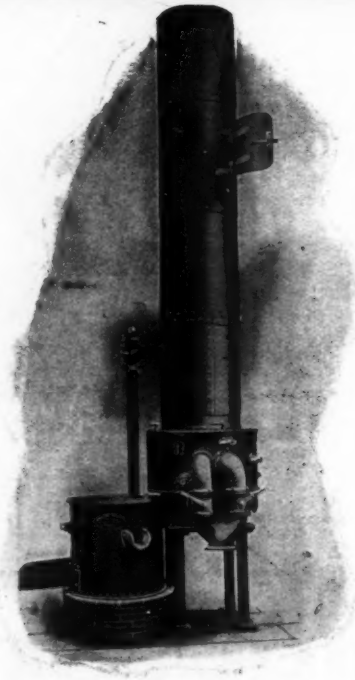

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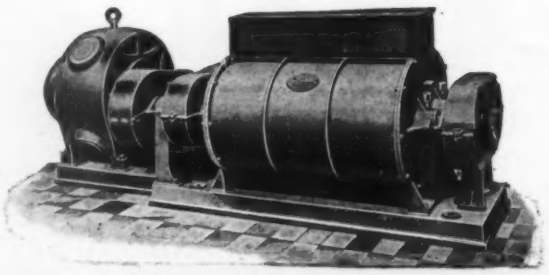

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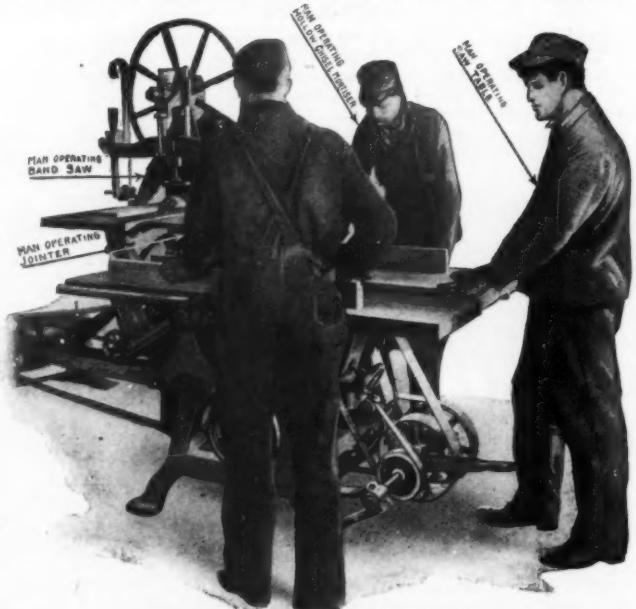

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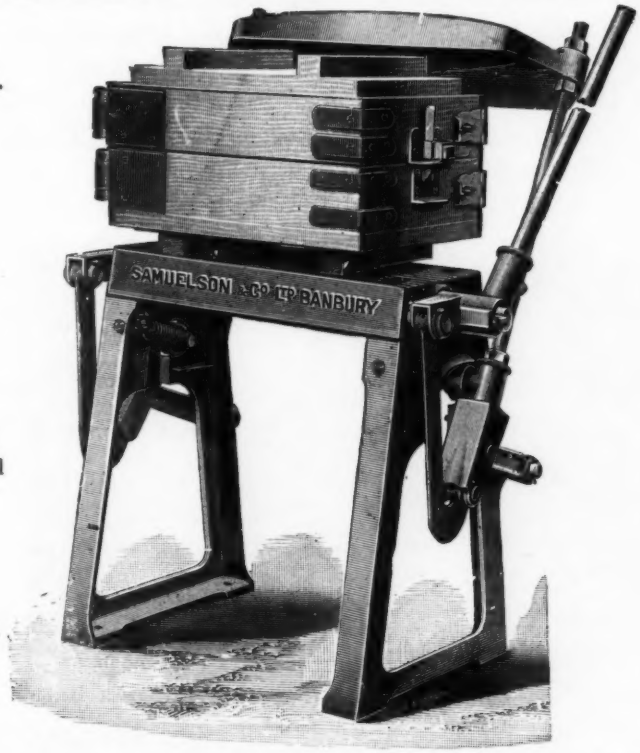

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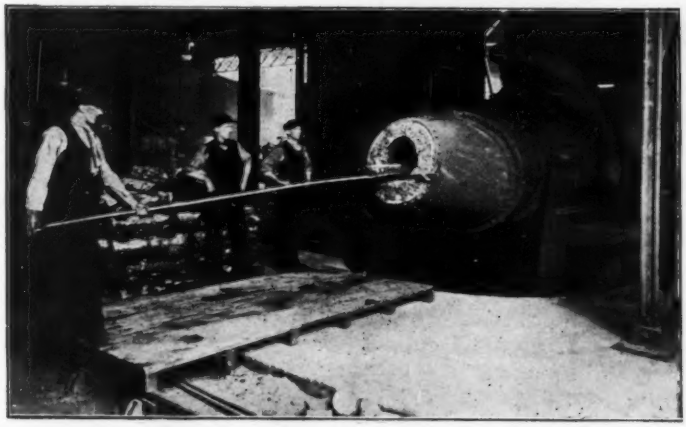

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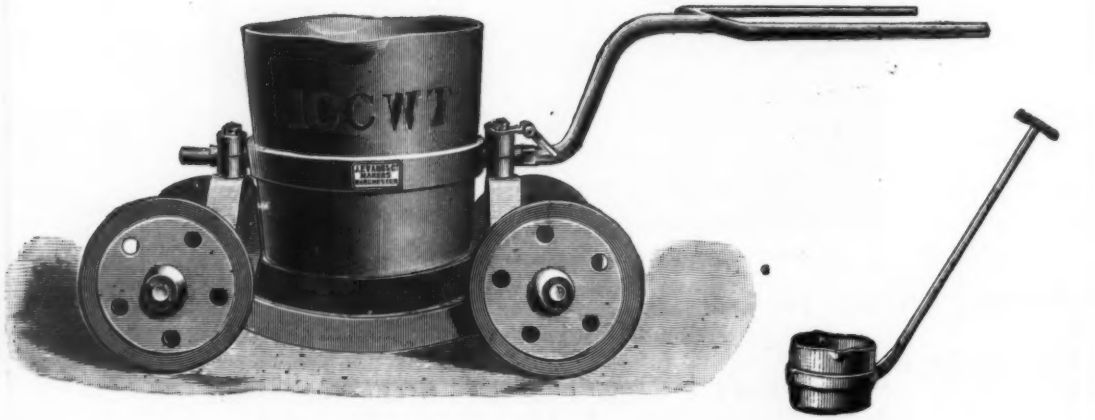

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NOTES AND COMMENTS.

The Efficient Foundry.

Discussing the subject of "The Modern Foundry Advance," before last month's annual meeting of the American Foundrymen's Association, Dr. R. Moldenke, the well-known American foundry authority, stated that the revolution in foundry methods and practices recorded in comparatively recent years was without parallel. Most of those engaged in the foundry business to-day could recall the time when the foundry foreman practically had sole control of the plant. He established prices, bought the raw materials and frequently made the most difficult moulds. On the cupola platform the melter charged the pig, scrap and fuel indiscriminately, though fairly well-proportioned, and as a rule, fairly good results were obtained. To-day, however, many foundry foremen possessed a knowledge of calculating mixtures and were conversant with the science of the industry. Progress in the art of casting metals was summarised as follows by Dr. Moldenke:—The grading of pig-iron by analysis in place of by fracture; introduction of machinery and processes to reduce costs and to promote more efficient operation; rational use of foundry materials; machine-casting of pig-iron; standardisation of methods, of sampling and analysis of pig and cast iron; classification of finished castings by their analysis ranges; operation of foundries with laboratory aid; introduction of standard specifications for pig-iron, cast iron and coke; broadening of shop practice to include oil and gas fuels, improvement of product by steel and alloy additions, introduction of the electric furnace, etc.; study of chemical and physical characteristics of cast iron and developments along lines of foundry betterment, including lighting, sanitation, safety, efficiency and foundry education.

We have no intention of disputing the accuracy of this statement of aggregate advances, but it is unfortunately the case, in this country at least, that while one or more of the advances in question may characterise a particular plant, in a great many very little of the progress in question is prominent. Advance may have been made along some of the lines mentioned, but in others the practice may be hopelessly antiquated. This is partly the result of the process of evolution through which foundry practice has been passing during recent years; but it is also largely to be accounted for by the absence of any concerted movement to establish standards of practice or ideals of conditions to which foundry owners, managers and workers generally may operate. Many of our foundries have grown from small concerns, and such growth seldom permits the best construction and lay-out for the work, such as a new plant can embody. Further, we have no institution to which a founder can turn for advice or guidance in any of the technical or practical difficulties that confront him, or which can refer him to or place in his hands extant information on processes and plant. An exception, perhaps, should be made in the case of the British Foundrymen's Association, in so far as a member can frequently glean valuable advice and information from its meetings and "Proceedings"; but since the work of the Association is essentially educational and covers

all grades of foundry operatives, it cannot be expected with its present constitution to carry out the work of co-ordinating the theory and practice of founding and stand as a permanent reference institution to which the progressive founder may turn. To say this is not to detract from its efforts and accomplishments; it is rather to define its past scope of operations. Whether the larger field will be entered in the future is for the future to decide; but the requirements of scientific founding demand it.

National Retrenchment and Educational Grants.

The inevitable movement towards retrenchment in public expenditure which will be occasioned by the unparalleled outlay now taking place for war purposes will probably involve the restriction of expenditure in several directions which one or another section of the community will class as false economy. On many matters it is not difficult, in the light of the new perspective created by the present war, to distinguish between the essentials and non-essentials in a nation's social or industrial fabric; but things that may not at first glance appear essentials may have an important influence on the stability, progress and recovery of our affairs from the shock of international conflicts. In some quarters the idea has been freely canvassed that the national expenditure on education might be considerably curtailed under present and near future conditions. This suggestion cannot be too strongly deprecated, for the education of the nation, from the lowest to the highest, is intimately associated with the country's economic welfare; and the progress of economic recovery would receive a serious set-back from an indiscriminate reduction of educational expenditure. We are quite prepared to admit that there is room in many directions for better and more effective application of the money devoted to education; but any money thus saved would be well spent if applied more directly to the educational demands of active industries. We have frequently laboured the necessity of closer co-operation between the schools and industries, and do not propose to discuss that subject further at the moment. But it is a duty to combat those who advocate the short-sighted policy of restriction, who would nullify one of the great possible aids of industry for the sake of a relatively few pounds to be saved temporarily.

The importance of this matter is evidently felt by the Vice-Chancellors of the Universities of Manchester, Liverpool, Leeds, and Sheffield (which institutions have contributed so importantly to industrial advance as to entitle them to a respectful hearing), for they have addressed a letter to the Joint Secretaries of the Committee appointed by the Treasury to consider the whole question of Public Retrenchment. The purpose of the letter is to deprecate the withdrawal of public subsidy from a branch of national education and research which is indispensable to the well-being of the country at the present time and vital to its future economic strength. The letter points out that it is the earnest wish and fixed intention of all who are concerned with the working of the four Northern Universities that, during the period of the war, expenditure should be reduced to the lowest point consistent with efficiency; but that as a considerable proportion (in all cases between a quarter and two-fifths) of the income of these Universities is derived from students' fees, the financial effect of the war upon their resources will be cumulative, and will probably be more serious next session than last, and worse still a year hence. Every penny of possible income is needed to carry on their work for the country. By far the most important part of the work of the Universities lies in the field of pure and applied science. They train chemists, physicists, doctors, dentists, public health officers, steel experts, civil, mechanical and electrical engineers, architects, farmers, colliery managers, textile managers, metallurgists, gas engineers, dyers, leather trade experts. The Northern Universities have in consequence been in a position to render very important (in some respects, vital) service to the State during the war; and their functions are not only national but Imperial.

There will probably be few who have come into close contact with the work of these institutions who will not accord them hearty support in their appeal; but we might extend the plea to cover all institutions which afford that technical education which our industries need, though the organisation and efficiency of many of the systems of instruction offered could well be examined for revision and improvement.

Producer Gas from Coke.

Producer gas of late years has made great headway in general applications, and, of course, is an essential to modern steel-making in the open-hearth furnace. The usual producer practice involves the loss or consumption of all the valuable by-products from the coal which are associated with "recovery" coke-making, and hence it is interesting to note the result of some recent experiments made in Germany with the use of coke instead of part of the coal charged in gas-producers. There is apparently, at the present time, some difficulty in Germany in getting the necessary amounts of gas-producer coal, as much more coal is being coked than formerly, because of the need for the by-products. The result is that constant effort is urged to replace coal by coke as much as possible. Many boiler plants have already adopted coke firing with good success, and recently experiments have been made in ordinary gas-producer practice. At a plant in Lorraine, coke has been used since the beginning of January with complete satisfaction. Coke alone has not been tried extensively. The average mixture was ½ to ¾ coke, and ¼ to ¼ of nut coal (15 by 35 mm.). The gas from this mixture was used in the heating furnaces for the rolling mills. No changes in the producers were necessary. The largest pieces of coke must be broken so that the size is not more than about 80 mm. It is stated that the work of poking is somewhat less than when coal is used alone. The coke settles down uniformly and does not form hollow places, for it does not swell and become soft when heated like the coal. The ash removal offers no difficulties. The coke contains practically no volatile matter, so that no heat is taken up for distillation. The producer therefore showed a tendency to run hot and it was found that about 10 per cent. more steam than usual had to be mixed with the air. Also the producers were found to gasify the same amounts of material as formerly. It is evident that the gas will be different in composition from ordinary producer gas. Average results of carefully taken samples from the plant mentioned before gave:—

	With coke.	With coal.
Carbon dioxide, per cent ..	2.0	4.1
Oxygen, per cent.	0.0	0.3
Carbon monoxide, per cent. ..	29 to 30	23.6
Hydrogen, per cent.	6 to 7	13.4
Methane, per cent.	0.5 to 1.0	2.6
Heat value, calories per cu. m.	1,130	1,285

The ordinary producer gas, at the first glance, appears to be the best. It is pointed out, however, that the hydrogen requires double the amount of air that the carbon monoxide needs, and that the nitrogen has to be raised to the temperature of

combustion. There are at present no exact results as to the comparison of the two materials for gas-producer work, but from a theoretical standpoint the coke would appear to be the best. It is often believed that the gas from the coke burns with a shorter, sharp flame, but this is said not to be the case. In the heating furnaces it shows an extremely long flame, somewhat more transparent than the ordinary flame, but clearly seen.

Factory Lighting.

On page 537 we give an abstract from the First Report of the Departmental Committee which has been enquiring into the lighting of factories and workshops. The recommendations are very interesting, and do not appear at all excessive in the demands they make on owners of plants. It is pointed out by the Committee that the minimum lighting values prescribed are considerably lower than those proposed by many witnesses, and are also lower than those found to exist in the majority of factories visited. In many cases manufacturers would naturally prefer to provide a substantially higher value that that indicated. The intention has been to propose values which can be adopted as a practical legal minimum without causing hardship, and would serve the purpose of raising the level of illumination in those factories which are behind modern practice in regard to methods of illumination.

The Committee did not feel justified in drawing any distinction between direct, indirect and semi-indirect lighting nor between systems which differ in the colour composition of the light. Similarly the standards are intended to apply equally to natural and artificial lighting; that is to say, when the natural illumination falls below the prescribed limits, it must be supplemented or replaced by artificial illumination. In appendices to the Report are given data which will be of service to those engaged in designing new factories and in examining the adequacy of lighting in existing buildings. At present there are few collated data of this character available, and the desire not to withhold them longer from publication is one reason for the submission of a preliminary report at this stage.

Adequate artificial lighting is an important matter in the utilisation of factories for night work, and a close connection appears to exist between the lighting conditions and the quality and output of work. The information contained in the Report should therefore be of special interest at the present moment, when many factories are working overtime, and preparations are being made for the period of the year when artificial lighting is mainly required.

Sulphur in Malleable Cast Iron.

The effect of high percentages of sulphur in cast iron for malleableising has long been appreciated in a general way, though the reason of the action of sulphur in preventing or retarding the breaking down of the carbide and the precipitation of carbon has not yet been satisfactorily explained. The malleable-iron founder simply knows that the black-heart process cannot be conducted with high-sulphur irons, and that even in the European process high sulphur is liable to give serious trouble. At the same time, the European process can be successfully conducted with five times the sulphur content that is permissible in the black-heart process, in which latter oxidation of the carbon by the packing material is not a feature. Just why this should be so has not been satisfactorily explained. It has been contended by Levy that the oxide of the packing material absorbs sulphur from the metal in immediate contact with it and allows the carbon change to proceed within that area, the remaining sulphur then diffusing outwards, the oxidising gases diffusing inwards, and the process thus proceeding towards the core. This view might appear to be supported by the fact that an increase in the sulphur content of the packing material has been noted in some cases; though it is probable that the increase in question when it does occur is derived from the fumes of the coal-fired annealing oven, for it does not occur in all cases. Nor would it appear from the Paper by R. H. Smith, presented before the Iron and Steel Institute last month (see page 530), that there is any actual elimination of sulphur, even in ore annealing (there would be none in black-heart practice, using neutral packing and low-sulphur irons). In black-heart practice, where the only serious oxidation of carbon from the iron occurs by reason of air obtaining access through the packing, there is difficulty in breaking down the carbide by heat treatment when the sulphur content exceeds 0.06 per cent.; while in European or ore-annealing practice the sulphur may go up to 0.40 per cent., and satisfactory results still be obtained, particularly if the manganese is proportionately high, since in the presence of proportionate manganese the sulphur forms manganese-sulphide and not the harmful iron-sulphide. Mr. Smith, in the Paper above-mentioned, however, comes to the somewhat disturbing conclusion that higher percentages of sulphur than 0.15 give unsatisfactory bending tests and low deflections. From the experiments on which this conclusion is based it is seen that the process in question is the European of Reaumur process, and hence the disturbing nature of such a conclusion; for as was pointed out by Dr. W. H. Hatfield, in the course of the discussion on Mr. Smith's Paper, to set as a maximum 0.15 per cent. of sulphur would disqualify 90 per cent. of the malleable cast iron made in the Birmingham and Walsall districts. The greater proportion of the Reaumur "malleable" produced in this country (and it forms probably 60 to 70 per cent. of the total) is worked on the basis of about 0.3 per cent. sulphur, and so far as ductility is concerned it appears to come well up to the blackheart or American product, which usually contains about 0.06 per cent. Dr. Hatfield referred to examples of European malleable cast iron which contained 0.5 per cent. sulphur, and which were excellently ductile.

To set the maximum at 0.15 per cent. is to demand that a large proportion of the iron used for such work in this country be imported, for there are not many British irons which would conform to the specification. Nor can it be claimed, in the face of English "malleable" practice during the last couple of hundred years, that such a specification is necessary. Mr. Smith's conclusions obviously apply only to the material with which he experimented, and certainly do not relate to the normal practice followed in this country. The carbon content of his iron was not high (about 3.15 per cent) and the silicon was low (0.69 to 0.73 per cent.); while the manganese content was also very low, being merely 0.02 per cent., as compared with 0.4 per cent. and over frequently used. It occurs to us that had the experiments been conducted with an iron higher in either silicon or manganese, the conclusion in regard to maximum sulphur content would have been different. With respect to the silicon, this can often be as high as 1.25 with low carbon (say 2.5 per cent.), and sulphur normal for Reaumur iron (0.25 to 0.3 per cent.), particularly if the casting is thin enough to cool fairly quickly.

Sulphur in Malleable Cast Iron.*

By R. H. Smith.†

The following research was undertaken at the suggestion of Professor Turner, in order to ascertain whether sulphur, when present in white iron as iron sulphide, is removed during the process of annealing in the production of malleable castings; and if removed, what conditions favour its removal. Professor Turner had previously proved that the sulphur which existed in the spent oxide used in the annealing process was in the form of a sulphide which readily evolved sulphuretted hydrogen when treated with hydrochloric acid, but whether this sulphur were absorbed from the white iron or from the furnace gases was not proved.

As early as 1884 Greenwood‡ had stated: "While other authors generally accept the process as one by which carbon, silicon, sulphur and manganese are removed from the surface of the pig-iron by a process of oxidation, others, like Mallet, Forquignon, etc., dispute this theory."

Dr. Levy, in a Paper on "The Mechanism of the Production of Malleable Castings," presented before the Birmingham Branch of the British Foundrymen's Association, stated: "The oxide appears to absorb (sulphur) from the metal in immediate contact with it, by the removal of which the carbon change becomes possible within a restricted area, resulting in local deposition of annealing carbon, the removal of which by the oxygen and carbon-dioxide is now able to proceed. The well known diffusive power of the sulphides, and of the carbon in iron, proceeding outwards, and the inward diffusion of the oxidising gases, lead to the production of a progressively thickening outward layer of malleable iron, enclosing a core in which sulphur and combined carbon may still remain in reduced quantity."

Dr. Levy's views have been discussed by Dr. W. H. Hatfield, who, while agreeing that the presence of sulphur increases the stability of iron carbide at high temperatures, does not accept Levy's explanation of a balling up of iron sulphide as being the cause of this action, but attributes it to the small percentage of sulphur which is associated with the carbide crystals.

Preliminary Experiments.—The object of these experiments was to ascertain in what manner and to what extent sulphur is removed during annealing. Two series of small test-pieces were employed in the primary experiments. They were cylindrical in shape, 4 centimetres long and 1.5 centimetre diameter. The first series was obtained by melting, in a plumbago crucible, a white iron which had the composition given in the following table. No additions were made, and when melted the metal was poured into green-sand moulds. The second series was prepared in a similar manner, except that, before pouring, a little ferro-silicon was added and the charge thoroughly stirred.

It will be observed that during remelting 0.25 per cent. of silicon, and 0.2 per cent. of carbon, were lost as a result of oxidation.

Since the material contained such a low percentage of manganese, it follows that the larger proportion of sulphur must have been present as iron sulphide. This was seen to be the case when the metal was examined microscopically.

Experiment 1.—Two test-pieces, or series A, were placed in separate annealing boxes with an annealing

	Original white iron.	White iron remelted.	
		Series A.	Series B
	Per cent.	Per cent.	Per cent.
Combined carbon	3.126	2.99	3.00
Graphitic carbon	0.136	0.07	0.09
Total carbon	3.262	3.06	3.09
Silicon	0.71	0.46	0.65
Sulphur	0.39	0.39	0.39
Manganese	0.056	0.053	0.05
Phosphorus	0.06	0.06	0.06

mixture consisting of two parts of spent oxide and one part of unused oxide. After the lids were luted on, the boxes were placed side by side in a small gas-fired annealing furnace, the temperature of which was gradually raised to 900 deg. C. This temperature was maintained within ± 5 deg. C. for fifty hours, and the furnace was then allowed to cool gradually.

When the annealed material was examined microscopically, the iron sulphide was seen in the form of small globules scattered throughout the ground mass. It is noticeable that the iron sulphide could be seen round the edges of the specimen. It was expected that, if the sulphur had been removed to any extent during the annealing, the metal immediately underlying the surface would have shown evidence of this removal by being free from the sulphide.

As a result of the micro-examination, the metal for analysis was machined off the specimens in the following manner: (A.) Turnings taken from the whole surface of the test-piece. (B) Turnings taken from a layer 3 millimetres inside the circumference. (C.) Turnings taken from a layer 3 millimetres inside layer B. These turnings were separately analysed, with the following result:—

	A.	B.	C.
	Per cent.	Per cent.	Per cent.
Combined carbon	1.08	Not estimated	
Graphitic carbon	0.9	"	
Total carbon	1.98	"	
Sulphur	0.39	0.39	0.39
Silicon	0.345	0.35	0.346
Phosphorus	0.06	0.06	0.06
Manganese	0.05	0.05	0.05

These analyses show that there was no diminution in the total percentage of sulphur, and no concentration of sulphur in any particular portion of the metal.

The annealing mixture employed in this experiment consisted, as before stated, of two parts of used oxide of iron and one part of fresh oxide. It was analysed for sulphur before and after the specimens had been annealed. The results are as follows:—

	Before annealing.	After annealing
Percentage of sulphur	0.432	0.22

* Abstract of Paper presented before the Iron and Steel Institute, September, 1915.

† Wiggin Scholar in Metallurgy, Birmingham University.

‡ "Steel and Iron," p. 282.

These figures reveal the quite unexpected fact that some of the sulphur originally present in the annealing mixture had been removed during the annealing, but that none of it had diffused into the iron.

In connection with this observation it may be mentioned that Professor Savoia has given figures to show that the mechanical properties of bars annealed in a mixture of iron oxide and sand were inferior to those which had been annealed in ordinary sand. He suggests that this inferiority is due to "the sulphur in the iron ore impairing in some measure the mechanical properties of the pieces heated in contact therewith."

Although the author has repeated the experiment with white irons of different composition, and at varying temperatures, in no case was the sulphur content of the metal found to have increased, but in every case the iron oxide contained less sulphur after the annealing operation than before. In subsequent experiments also, the sulphur contained in the white iron was not removed, even when the iron oxide contained very little sulphur.

It is difficult to reconcile Professor Savoia's explanation with the fact that the sulphur of the iron oxide does not diffuse into the white iron during the annealing process; while the sulphur already present in the white iron does not diffuse into the iron oxide. It is not easy, therefore, to understand what deleterious effect the sulphur contained in the iron oxide can have upon the mechanical properties of the malleable cast iron.

The spent oxide used in the annealing mixture in the preliminary experiments was a fair sample obtained from a local works. But it was thought that the large percentage of sulphur already contained in the annealing mixture might have prevented any sulphur being absorbed by the iron oxide. A specially prepared annealing mixture was therefore used in all the following experiments. It contained the same proportions of unused and spent oxides, but being made from pure materials it contained very little sulphur, viz. 0.04 per cent. After each experiment the oxidising medium used was analysed, and in no instance was there found to be an increase, but always a reduction in the content of sulphur.

Experiments with Different Annealing Mixtures

In order to study the effect of different atmospheres upon the iron sulphide, three test-pieces of series A were embedded in separate annealing boxes, which were respectively charged with (A) ordinary annealing mixture; (B) powdered carbon; (C) dried bone ash. The ferric oxide would produce an oxidising medium, the carbon a reducing atmosphere, and the bone ash a neutral one.

The lids were luted on the boxes, which were then placed in the annealing furnace and the temperature gradually raised to 900 deg. C. After fifty hours the furnace was allowed to cool slowly. All the specimens, after annealing, could be filed quite easily, but when the material was machined a difference in hardness between the interior and exterior of "B" was apparent. The central portion, although not so hard as white iron, was very hard. When the specimens were examined microscopically, no difference in the appearance of the iron sulphide could be observed in the three tests. In each case it was in the form of small globules, and, as in Experiment No. 1, it could be seen in the metal immediately underlying the surface. The central portion of "B" consisted of practically unchanged white iron; and the iron sulphide existed, in this portion, in the same manner as in the original white iron, no change having taken place. This result is interesting, as Levy* states: "The only differences in the structure of the white centres of the different irons were due to the presence of large yellow-brown sulphide areas, derived from the massing together of the original sulphide constituent of the eutectic."

In every case when carbon was used as the annealing medium this unchanged core of pearlite and cementite was seen, but in no instance was there any massing together of the sulphide. The analyses of the samples after annealing were as follows:—

	A.	B.	C.
	Per cent.	Per cent.	Per cent.
Combined carbon	1.10	1.76	1.34
Graphitic carbon	0.85	0.36	0.64
Total carbon	1.95	2.12	1.98
Sulphur	0.39	0.392	0.386
Silicon	0.35	0.36	0.41
Phosphorus	0.06	0.06	0.06
Manganese	0.05	0.05	0.05

Tests at a Higher Temperature.—The same metal and packing materials were employed in this experiment as in the previous one, the only difference being that the annealing temperature was 970 deg. C. instead of 900 deg. C. This course was adopted because in practice the annealing temperature usually employed varies between 900 deg. C. and 980 deg. C. It was also thought that the higher temperature might have some effect upon the iron sulphide. Subsequent analysis showed, however, that the sulphur content was not reduced, and when the specimens were examined microscopically the small globules of iron sulphide described in the previous experiments could still be seen. The analyses agreed closely with those previously obtained.

Tests with Higher Silicon Content.—The two previous experiments were repeated, but instead of using test-pieces belonging to series "A," metal containing a higher percentage of silicon, series "B," was employed. In each case, when the specimens were examined microscopically, the small globules of iron sulphide were seen. They were not concentrated in any particular portion of the material, and were also seen in the metal underlying the surface. That the sulphur had not been removed could be seen from an inspection of the analyses. The annealing temperature was 900 deg. C. The experiment was repeated at an annealing temperature of 970 deg. C., with similar results.

It is noticeable that in all the preceding annealing experiments, when the test-pieces were heated with carbon, the carbon content was reduced from 3.1 per cent. to approximately 2.1 per cent. The carbon in excess of that soluble in iron at the temperature used was apparently partly removed as carbon-monoxide. The fact that the carbon was so removed was confirmed by the microscopical examination. In every case temper carbon was seen in the annealed specimens.

Check Experiments.—In order to confirm the laboratory results, four test-pieces, two of each series, were annealed by Messrs. Shutt & Ganderton, Malleable Iron Founders, Suffolk Street, Birmingham. The specimens were packed in annealing boxes in the ordinary way, together with other castings of a like section, and subjected to annealing conditions which practical men had found by experience to be the most suitable. Unfortunately there was no facility at the works for taking correct temperature measurements.

Their results, obtained under ordinary works conditions, agreed exactly with those given by the

* "Journal of the Iron and Steel Institute," No. II., p. 33.

laboratory tests, and showed that no sulphur was lost. The change was confined to the carbon.

If by any chance air gained access to any of the annealing boxes, and a layer of oxide was consequently formed, the experiment was always repeated. However, more for curiosity than for any other reason, the scale was removed from the oxidised material, and the sound portion analysed An increase in the sulphur content was always noted when oxidation had taken place, the increase varying with the thickness of the oxide layer. The following experiment was therefore made:—Two test-pieces, one of series "A," and the other of series "B," were packed in annealing boxes with iron oxide. Lids were placed upon both boxes, but not luted on; air therefore had free access to the interior. The boxes were placed in the annealing furnace and the temperature gradually raised to 1,000 deg. C. After a period of sixty hours, the furnace was allowed to cool gradually.

When the annealing boxes were discharged, a layer of oxide had formed on each specimen, as was expected. Upon removing this oxide it was found that about one-half of the original white iron had been oxidised.

	Series A.		Series B.	
	Metal.	Scale.	Metal.	Scale.
	Per cent.	Per cent.	Per cent.	Per cent.
Combined carbon ..	0.67	—	0 74	—
Temper carbon ..	0.62	—	0.7	—
Total carbon ..	1.29	—	1.44	—
Silicon..	0.42	—	0.67	—
Sulphur	0.44	0.29	0.48	0.24
Phosphorus	0.06	—	0.06	—
Manganese	0.05	—	0.05	—

Both specimens were examined microscopically, and in each case the iron sulphide was concentrated in the metal immediately underlying the surface, although numerous globules appeared in the remaining area. From the microstructure it seemed that when the surface of the metal was oxidised, the sulphide, instead of remaining in the oxidised layer, liquated into the unoxidised metal. When the scale and unoxidised metal were analysed, this assumption was found to be correct. It will be remembered that the original metal contained 0.39 per cent. of sulphur.

Effect of Sulphur on the Mechanical Properties.—In none of the preceding experiments was the sulphur found to have decreased in the annealed white iron; it was therefore decided to make a series of test-bars with varying percentages of sulphur, the other constituents being kept as constant as possible. In this manner it was hoped that the effect which iron sulphide exerted upon the mechanical properties of malleable cast iron would be ascertained, and also that, by analysing the annealed test-bars for sulphur content, it would be seen whether, with smaller percentages of sulphur than 0.39 per cent., any sulphur was removed during annealing.

An American washed iron, containing about 3.0 per cent. combined carbon with traces only of other impurities, was taken as the base in the preparation of the bars. It was melted in a plumbago crucible with a calculated amount of ferro-silicon; when melted, the requisite quantity of iron sulphide was added. After stirring, the metal was cast into green-sand moulds.

Transverse tests were made on 1-in. square bars between 8-in. centres; tensile tests on round bars 9 in. long, 6 in. of which had a diameter of ¾ in.; and bending tests upon bars 9 in. long by ½ in. square.

Tests were made on the original white iron, and the corresponding bars of each set were packed together in an annealing box and annealed. The annealing mixture employed was the same in each case, therefore it was anticipated that any difference in the mechanical properties of the annealed bars would be solely due to the varying amounts of sulphur, since the silicon, carbon, manganese, phosphorus and heat treatment did not vary. The analyses of the series of bars are given in the Paper. The sulphur varies from 0.01 to 0.34 per cent., the other constituents being very constant throughout the series.

The transverse strength was little influenced by the addition of sulphur, the tensile strength increased, while the elongation and deflection decreased. The most marked effect observed was in the bending tests, which were very unsatisfactory when the sulphur was much above 0.15 per cent.

The author's conclusions are that, in the production of malleable cast iron: (1) Sulphur is not removed during the ordinary annealing process; (2) when the exterior of the casting is oxidised, sulphur tends to segregate into the unoxidised portions; (3) sulphur does not appear to have any markedly injurious effects on the product until about 0.15 per cent. is present. Higher percentages give unsatisfactory bending tests and low deflections.

CUTTING-TOOL RESEARCH.—A report on past experimental work on cutting tools has been presented to the Tool Research Committee of the Manchester Association of Engineers by Mr. Dempster Smith, who collaborated with the late Dr. Nicolson in the classical researches undertaken under the auspices of the Association. The report runs to some 120 pages of closely-printed matter, and though only a summary of the research work on the subject, reveals considerable discordance of results even amongst those who have made it a special study. As regards even the simple relations between cut, speed, and angle, etc., Mr. Smith observes that though the conclusions of the various enquirers may accord within certain narrow limits there is no general agreement over the ranges commonly prevailing in practice, and as no rational laws have been advanced to reconcile these differences he recommends further research work, particularly on the following points:—(1) A method of measuring the efficiency of the preliminary treatment of a tool or its cutting capacity without subjecting it to actual cutting or impairing its cutting edge. (2) A method of measuring the resistance of the metal to cutting, say by means of a Brinell scleroscope, or other instrument, or the relation between the physical properties and resistance to cutting of the metals. (3) The most economical shape of tool for roughing purposes having regard to the number of re-grindings and re-temperings between each re-dressing, the time lost in removing and replacing the spent tool, process and steel costs. (4) The most durable shape and angles for the various metals. Are these affected by the speed, cut, or when working with or without lubricant? (5) The most economical cutting speed corresponding to the duration of cutting for each section of tool steel. (6) The relation between cutting speed and duration of run for several cuts and traverses. (7) The relation between the cut, feed, and speed when operating on steel and cast iron. (8) The effect of treated and untreated scale or skin on steel and cast iron on the cutting speed. (9) The effect of lubricant on the cutting speed. (10) The relative cutting capacities of ordinary high-speed, vanadium and cobalt steel.

American Foundrymen's Conference.

Annual Meetings of Associations.

AMERICAN FOUNDRYMEN'S ASSOCIATION.

The twentieth annual meeting of the American Foundrymen's Association was held on September 28 to October 1, at Atlantic City, when that and the allied Associations foregathered. The opening session was a joint meeting with the American Institute of Metals, when, following the addresses of welcome, the report of the A.F.A. Committee on Safety was presented by A. W. Gregg. An address on "Tests of Lenses for Foundry Goggles," by F. W. King, was accompanied by a demonstration of a lens-testing machine and a coloured spectrascopic lantern test showing scientifically colours of lenses used in dangerous conditions of light and glare. The report of the A.F.A. Committee on Industrial Education was then presented by Frank M. Leavitt.

A Paper which followed, on "Functions of Sand Binders," by Henry M. Lane, is given on page 541, while other Papers on the session's programme were:—"Notes on Applications and Characteristics of Cores in Modern Moulding," by R. A. Bull; and "Moulding Sands," by C. P. Karr (Bureau of Standards, Washington).

The afternoon session's Papers were:—"Report of A.F.A. Committee on Specifications for Foundry Scrap," by S. D. Sleeth; "Patternmaking for Moulding-Machine Work," by E. I. Chase; "Foundations for Jar-Ramming Moulding Machines," by E. S. Carman; "The History and Development of the Moulding Machine, with Sidelights on Latter-day Practice," by J. J. Wilson and A. O. Backert; "Scientific Management and its Relation to the Foundry Industry," by H. K. Hathaway; "Reclaiming Moulding Sand," by W. M. Saunders and H. B. Hanley (see page 550); "The Relation of the Foundry Foreman to His Employer," by S. V. Blair.

On Wednesday, September 29, the report of the A.F.A. Committee on Costs was presented by B. D. Fuller, chairman (see below), the following Papers also being on the programme:—"The Modern Foundry Advance," by Dr. Richard Moldenke; "Manufacture, Constituents, and Essentials in the Purchase of Pig-iron for Foundry Use," by Oliver J. Abell; "Organisation in the Foundry of the University of Illinois Shop Laboratories," by R. E. Kennedy and J. H. Hogue; "The Structural or Mechanical Theory of the Effect of Rust on Cast Iron and Wrought Iron or Steel," by R. C. McWane.

On Wednesday, September 29, the programme included:—"Pouring Systems for Grey Iron Foundries," by H. Cole Estep; "Fuel Oil Cupolas," by Bradley Stoughton; "Inspection of Automobile Castings," by C. B. Wilson; "Common Defects in Grey Iron Castings: Their Causes and Remedies Therefor," by H. M. Ramp; the report of the A.F.A. Committee on Specifications for Grey Iron Castings, by W. D. Putnam; and the report of the A.F.A. Committee on Standard Methods for Analysing Coke, by H. E. Diller.

On Wednesday, September 29, the A.F.A. held its annual business session, when the address of the President (Mr. R. A. Bull) was presented, followed by the report of the Secretary-Treasurer (Mr. A. O. Backert), the election of officers, and miscellaneous business.

On Thursday, September 30, a "Steel Session" was held, the following Papers being listed:—"Dynamic Properties of Steel Employed in the Manufacture of Castings of Various Types," by J. Lloyd Uhler; "The Particular Application of the Converter in the Manufacture of Steel Castings," by C. S. Koch; "Notes on Electric Furnace Construction and Operation in the Steel Foundry," by James H. Gray; "Open-hearth Furnace-Checker Design," by W. A. Janssen; "Causes of Shrinkage Cracks in Steel Castings," by W. R. Bossinger (see page 549); report of A.F.A. Committee on Specifications for Steel Castings, by W. C. Hamilton; report of A.F.A. Committee on Steel Foundry Standards, by Dudley Shoemaker and R. A. Bull; "Notes on Arc Welding," by R. Kinkead.

A "Malleable" session followed, the papers being:—"Some Remarks Regarding the Permissible Phosphorus Limit in Malleable Iron Castings," by Professor Enrique Touceda; "Standardisation of Air Furnace Practice," by A. L. Pollard; "An Outline to Illustrate the Interdependent Relationship of the Variable Factors in Malleable Iron Practice," by L. E. Gilmore; "Malleable Practice," by J. P. Pero and J. C. Nulsen; "Coal: Its Origin and Use in the Air Furnace," by F. Van O'Linda (see page 543).

On Thursday, September 30, the annual banquet was held at Hotel Traymore, while Friday, October 1, was devoted to the introduction of new officers, the report of the committee on resolutions, the appointment of standing committees, and unfinished business.

Report of the Cost Committee.

In the report of the Cost Committee of the American Foundrymen's Association, the adoption of a uniform basis of figuring costs by foundrymen generally is recommended. The factors constituting this uniform basis follow:—

(1) A commodity sold by a foundry is the labour of the moulder and coremaker, and not the material entering into the product.

(2) The material is more or less a constant, varying with market conditions.

(3) Cost of production fluctuates in proportion to pounds of output per moulder.

(4) Overhead charges increase or decrease, according to pounds of output per moulder.

These various factors are discussed in detail, and an interesting method of figuring the overhead is presented. The work is divided into two classes, namely, slow-moving and fast-moving, and it is stated that slow-moving jobs should carry a higher percentage of "overhead" than fast-moving jobs. Examples are cited which prove conclusively the correctness of this theory. Simple instructions are given for arriving at the proper cost. To promote the adoption of a uniform method of keeping costs, the Committee recommends that 100 foundrymen guarantee a fund by the payment of £10 each, or 50 foundrymen guarantee to pay £20 each, during the period of one year. Each of these foundrymen then would have first call on the services of this cost expert, and during the year he could remain at each of their plants a sufficient time to teach the accountants the basis or theory of the system recommended. Also, it is suggested that general meetings be held in the various localities visited by the cost accountant during the year, and the system then could be fur-

ther explained to interest foundrymen generally in the adoption of the uniform cost theory.

The method of working recommended will be dealt with in a future issue of our paper.

Standard Methods for Analysing Coke.

The report of the Committee on Standard Methods for Analysing Coke was as follows:—

Since this Committee was appointed last May it has been working in conjunction with similar committees of the American Society for Testing Materials and the American Chemical Society in outlining methods for analysing coke which can be adopted by each of the three societies, thus giving uniform methods of procedure for testing for all disputed cases. Satisfactory progress is being made, and only a few points remain to be decided before the methods can be reported for adoption.

The usual temperature limits allowed for drying the coke in a moisture determination seem considerably lower than necessary, and a higher limit would enable the average foundry to dry a large sample without extra equipment. Tests, therefore, are to be made to determine how high coke may be heated in drying without vitiating the results.

In order to determine the volatile matter with much precision, it is necessary to ascertain with a pyrometer the temperature to which the coke is heated during the determination and to hold this temperature within comparatively narrow limits. But as a general thing the foundryman does not require a great degree of precision in the determination of volatile matter, and consideration will be given this and a method probably outlined for use where the coke is not bought to specifications with rigid requirements for volatile matter.

As to the proper implements to be used in pulverising the sample, different methods will be tried by the members of the committee, and the amount of foreign substance which is introduced into the sample through the use of different implements for crushing will be determined.

There are two accurate methods in general use for the determination of sulphur in coke, namely, the Eschka and the sodium-peroxide methods. Only one of these will be adopted as a standard. This will be mainly for use as an umpire method, and for this reason every precaution will be taken to insure accuracy, which will probably make it too long for routine work. For this reason the Committee is considering the advisability of outlining and recommending for adoption by the Association, for routine tests, a shorter method which will be sufficiently reliable and give results close enough for commercial work.

AMERICAN INSTITUTE OF METALS.

In addition to the joint meeting with the American Foundrymen's Association on September 28, the programme of the Institute included an afternoon Session, with the following items:—Report of Official Chemist; "An Investigation of Fusible Tin Boiler Plugs," by Dr. G. K. Burgess; "The Influence of the Impurities of Spelter on the Cracking of Slush Castings," by G. Rigg; "Cobalt in Non-Ferrous Metals," by H. T. Kalmus; "Furnace Methods for Pure Castings," by F. L. Antisell: "Standard Test Specimen of Zinc-Bronze: Cu, 88, Sn. 10, Zn. 2. Relation of the Mechanical Properties to the Microstructure," by Dr. H. S. Rawdon: "Notes on the Copper-Rich Kalchoids," by S. L. Hoyt.

On Wednesday, September 29, at the morning Session, the Papers were:—"The Effect of the Present European War on the Metal Industries," by T. F. Wettstein; "Sherardising," by Dr. S. Trood; "Electric Furnace for Brass Melting," by F. A. S. Fitzgerald; "Substitutes and Alloys to take the Place of Platinum," by W. E. Mowrey; "Alloys of Nickel, Chromium and Copper," by D. F. McFarland and O. E. Harder. In the afternoon an aluminium session took place, when the following Papers were listed:—"Aluminum Die Castings," by C. Pack; "The Manufacture and Use of Alumino-Vanadium," by Wm. W. Clark; "Recent Advances in the Manufacture and Uses of Aluminum," by E. V. Pannell; "The Welding of Aluminum," by E. V. Pannell; "Aluminium Bronze Alloys," by W. M. Corse.

Further Papers presented on Thursday, September 30, were:—"Development of an Acid-resisting Alloy," and "Methods of Analysis for Complex Alloys," by S. W. Parr; "Effect of Zinc on Copper, Tin, Lead Alloys," by G. H. Clamer; "The Advantages of a Standard Railway Journal," by Russell R. Clark; "Forging Manganese Bronze," by Jesse L. Jones; "The Failure of Structural Bronzes," by Dr. P. D. Merica; "Experiences with Brass in Civil Engineering Work," by A. D. Flinn; "Stellite," by Elwood Haynes.

ROOF CONSTRUCTION AND STEEL-FURNACE YIELD.—For the past three or four years the Illinois Steel Company has operated its open-hearth furnaces with the Orth ribbed-roof construction. Exceptionally good results have been obtained. In the year 1914 the average production per roof on all of the furnaces of the No. 2 open-hearth department was 24,600 tons. These furnaces are rated at 50 tons, and, with the exception of one furnace in which tar was used, all were fired with producer-gas fuel. This record, which is representative of the results steadily obtained with the Orth roof during its use at South Chicago, compares with an average production of 17,041 tons previously obtained with ordinary roofs. In addition to the prolonged life of the roof due to the ribbed construction, it is possible to shut down the furnace more freely for cleaning chequers or for repairs than with the ordinary roof where there is the attendant hazard of losing the roof when furnace operations are resumed. It is possible, therefore, with the stronger roof, to keep the furnace in better operating condition, which is reflected in larger production and lower operating costs.

HIGH-PRESSURE FANS FOR CUPOLA WORK.—The Sturtevant Engineering Company, Limited, have issued an illustrated pamphlet dealing with Sturtevant high-pressure fans. These fans are extensively used for blowing cupolas, and are claimed to be superior to rotary blowers of the Roots and similar types, because the fan impeller is not subject to any wear and retains its original efficiency after years of service. For cupola blowing sufficient air must be furnished at a pressure high enough to force its way through the charge, and for a given size of cupola or weight of iron to be melted, the Sturtevant high-pressure fans are said to be ideal. The fans require no attention proper beyond lubrication of the bearings. Electrically-driven fans present marked advantages over the belt-driven types, on account of their complete independence of main engine or line shaft, absolute freedom of choice in location of fan, avoidance of high-speed belts, economy in running cost, no power being wasted by intermediate shafting, perfect regulation of speed by electric control, and ready determination of exact power exerted to drive the fan. These features are of exceptional value for foundry purposes, as it is most important that the working of the cupolas should be determined only by the requirements of the foundry and not subordinated to the running of the main engine or line shaft. As the foundry is usually at a distance from the main engine or power house, the saving in running cost effected by electric instead of mechanical power transmission is considerable.

Standardisation of Air-Furnace Practice.*

By A. L. Pollard.

The air furnace must not be too high in first cost and must be adaptable to a fairly wide range of capacity. With the data now available, there is no reason why an air furnace should not be constructed which would work exactly the same every day under the same general conditions. The design is the first consideration. One dimension is limited, namely, the width. The furnace must be narrow enough to permit easy skimming as well as to allow the construction of easily-supported bungs. This width is approximately 7 ft. inside. The design is then confined to six main points, as follows:—(1) Length of hearth; (2) depth of bath; (3) length of firebox; (4) height of roof; (5) opening at neck; (6) wall thicknesses.

Length and Depth of Hearth.—The length of hearth and depth of bath are mutually dependent. To design a furnace of any particular capacity, we may start with an average bath of 6 in., which will give quick melting, or of some other depth, such as 10 in., which will give slower melting and somewhat colder iron. For average practice the writer recommends a depth of 8 in. With the tonnage, width and depth given, it is a matter of arithmetic to determine the length of hearth. The hearth should be deepest just in front of the bridge wall where the heat is most intense, and shallow at the neck where melting is much slower. The tap hole, of course, is located at the deepest point of the hearth.

Grate Area.—The grate area is a factor of much importance, and is entirely a matter of experience. This area can be determined in two ways. It has been found that the ratio of grate area to hearth area should be about 1 to 4. Also, since the melting ratio is 1 to 3, or better under forced draught, and since about 50 lbs. of coal per sq. ft. per hour should be burned we can calculate the area in this way. If we should consider natural draught, we would assume only 30 lbs. of coal per sq. ft. per hour and a fuel ratio of 1 to 2½. With forced draught we would obtain a melting speed for a 10-ton furnace of about 4½ hours. Natural draught would be much slower.

Height of Roof.—The roof must be high enough to allow free passage of the flame when the furnace is charged with cold stock. In a 10-ton furnace this will be about 3 ft. 6 in. at the deepest point. The roof should be no higher than necessary, as the most effective heating factor is in radiation from it. Also, it has been shown that gases are most effective in heating when moving at a high velocity. Obviously, the lower the roof, the greater this will be. The roof should be as nearly flat as possible, sloping gently down at the back. There is absolutely no advantage in the wierdly-curved and indented roofs which some old furnaces have.

Opening at Neck.—The opening at the neck is a point of great importance. It must be just right for successful operation. It is entirely dependent upon the volume of gases passing through the furnace and upon the draught. This opening in a 10-ton furnace should be about 3 sq. ft. in area, but it should be adjusted as conditions of draught vary to always give a slight back pressure in the furnace. In other words, the total pressure of gases at this point should slightly overbalance the suction from the stack. Of course, in a natural-draught furnace this relation cannot be maintained, and consequently little or no air can be admitted over the bridge wall. The necessity for this back pressure is due to the fact that unless there is an appreciable pressure, a large amount of air is sucked in through the doors and roof, which tends to cool the furnace and greatly lower its efficiency.

Walls.—The furnace walls may be either 9 or 13 in. in thickness. Thirteen inches is best and most economical. Less heat is conducted through them, and at the slag line the inner 4 in. can be removed and replaced without disturbing the entire wall.

Disadvantages in Air-Furnace Construction.

The possibilities for improvement in air-furnace construction open an interesting subject for speculation. The disadvantages of the furnace may be briefly summarised as follows:—(1) Exhausting labour of firing and skimming; (2) large amount of heat lost in waste gases; (3) large amount of heat lost through bungs.

The labour of firing has long been a difficult point in air-furnace practice. It is difficult to get and keep good firemen. There are only three ways out of this difficulty, considering coal as fuel. One is the utilisation of the open-hearth furnace with regeneration, which we are not considering here. Another is in the use of automatic stokers. Some furnaces are equipped with these, which are giving satisfaction, but there is opportunity for much improvement. The writer believes that by far the most economical and best method of firing air furnaces is in the use of automatic stokers. A third method is by the use of pulverised fuel. This seems to offer possibilities, but it necessitates a large investment in equipment.

Concerning the heat lost in waste gases, unless we consider the open-hearth, there is absolutely no opportunity for improvement in the furnace itself. To attain a melting temperature in the furnace requires that the waste gases leave the furnace at that temperature. The waste-heat boiler offers a good method of utilising this lost heat, but this is outside our present discussion.

The heat lost through bungs also is difficult to overcome. Under present practice, where removable bungs are in use, the thickness cannot be much increased, as it is necessary to keep all parts of the brick, through which the resultant pressure line passes, below the softening temperature of the brick used. The only improvement that the writer can suggest is to make the roof permanent and suspend it from one or more points between the skewbacks. This, of course, would necessitate charging from side doors.

Furnace Operation.

Furnace operation starts with the mixture of pig-iron, sprue, scrap, etc. This is perhaps the simplest part of furnace operation; but for best results it must be done along scientific lines. Having the analyses of the various materials, knowing what we desire to do, and with data from a few heats showing what elements are oxidised and to what extent, it is then a simple matter to make the mixture. The decision as to the final analysis of the heat is very

* Presented at Annual Meeting of the American Foundrymen's Association, September, 1915.

important. It will depend largely upon the class of work. The writer's opinion is that the proper analysis should be about 2.50 per cent. carbon and as much silicon as the heaviest section will carry without precipitating graphite.

The really difficult part of air-furnace operation is in burning the proper amount of coal and adjusting the draught. Improper draught is the most frequent cause of failure This subject is simple in theory, but seems to be difficult in practice. Starting with a properly-designed furnace and a certain charge, we can find the amount of coal which should be burned. This amount of coal should then be shovelled in, at frequent intervals. Air enough should be admitted under the grate to burn all the coal with a somewhat smoky flame, and air enough should be admitted over the bridge wall to burn the fire-box gases with a clear flame. Next, the opening at the neck should be adjusted to give a slight back pressure. The back pressure is right when the flame just tends to shoot out from the furnace openings.

If the malleable business is to be standardised on a basis of high quality, we must know exactly what we desire to do, and then do it in a thoroughly scientific manner. It is quite possible to have every heat poured of the right analysis and at the right temperature, and this should be the constant aim. The question of proper annealing is so difficult that we cannot afford to complicate it by improper furnace operation.

Wooden Foundry Flasks.

By Walter J. May.

Flasks are generally made of metal—often cast metal—this enforcing rigid sizes and often considerable weight where it is not needed. The question therefore frequently arises as to whether it is advisable to increase the stock of flasks, or to adopt some more flexible system in regard to the smaller flasks, whereby various sizes can be readily produced when

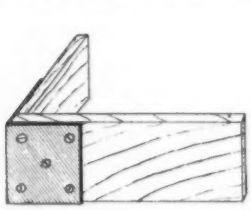


Fig. 1.

Fig. 2.

needed, and at a small expense. The method here described shows one way in which flasks of moderate size can easily be produced at a low cost. The flask sides and ends should be of well-seasoned wood of from ¼ in. to ⅜ in. in thickness, according to the length, the width being dependent on the depth of the flask part being made. In any case, they must not be light enough to spring apart when rammed up with sand, but excessive thickness is unnecessary. At the top and bottom of each board a fillet about half-an-inch square should be bradded on to assist in holding the sand and prevent slipping, but this hardly stiffens the boards appreciably.

The ends are of wrought-iron plate, ⅛ in. thick, carefully bent hot, and extending 4 in. to 6 in. along the sides and ends and, of course, being the width of the boards. These plates are held in position by cup-headed bolts with the nuts inside the flask.

The pins are held in place either by small bolts or by wood-screws, and should fit well. The pin brackets can be made of plate ⅛ in. thick, the pins being forged and screwed and having shoulders. If the flasks are always clamped together the pins should be solid, but where this is not the case a hole should be made through the pin to take a wedge. Plain pins can be made of ⅜-in. round rod, but where they have to carry wedges ½ in. stock is not too much.

In regard to handles, either wood or iron can be used, pieces of angle iron being useful for the job if

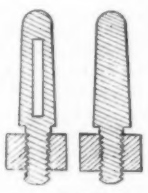


Fig. 3.

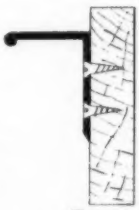


Fig. 4.

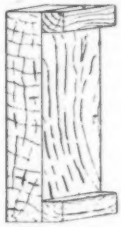


Fig. 5.

clear of sharp edges and scale. This, however, is a matter of local convenience because, while not purchasing angle iron for the purpose, pieces of old stuff might very well be worked up. As only small flasks up to from 2 to 3 ft. in length would be made, no special arrangements would have to be made as would be required in large, heavy flasks; but in some cases stays or bars might be desirable for facilitating some forms of moulding. These could be of wood, held in either by screws placed directly through the sides of the flask or by small angle irons attached to the bars and the inside walls of the flask.

Fig. 1 shows the end plate; Fig. 2, guide pin; Fig. 3, the two forms of pin used; Fig. 4, the iron handle; Fig. 5, the fillet; Fig. 6, the method of fastening the stays or bars; and Fig. 7, the complete drag part of a flask. Both for handiness and cheapness these wooden flasks are good, while for economising space they would be hard to beat. At the same time, they could only be used in small sizes, and large flasks would have to be made in metal. Usually, however, certain sizes of flask take the whole work of the foundry, and in many places nothing more than 2 ft. in length is needed. Even where large work is done there is a certain amount of small work that can be grouped, and here the advantage of such flasks as those referred to makes itself felt.

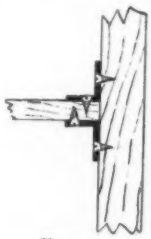


Fig. 6.

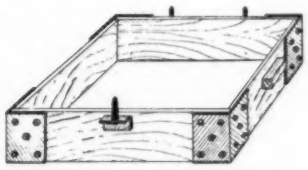


Fig. 7.

BITUMINOUS ROADS.—The use of oil fuel in industry has associated with it the use of various by-products of a very interesting nature. For example, the product known as "Mexphalte," a pure bitumen imported by the Anglo-Mexican Petroleum Products Company, Limited, is now very largely used in road construction. A similar product "Fluxphalte," is a liquid form for road spraying which has attained marked popularity.

Lighting of Factories and Workshops.

The Departmental Committee appointed in 1913 to inquire into the conditions necessary for the adequate and suitable lighting (natural and artificial) of factories and workshops has issued its first Report. The Committee—which comprised Dr. R. T. Glazebrook (Director of the National Physical Laboratory) as chairman; Mr. Leon Gaster, Professor Francis Gotch (since deceased), Messrs. J. Herbert Parsons, and W. C. D. Whetham, Sir Arthur Whitelegge, K.C.B. (Chief Inspector of Factories), and later, Professor C. S. Sherington, M.A., with Messrs. D. R. Wilson (H.M. Inspector of Factories) and C. C. Paterson (of the National Physical Laboratory) as Secretaries—met for the first time in London on February 11, 1913. Since then 38 meetings have been held. In view of the wide ground covered by the terms of reference, it was thought desirable to limit the inquiry in the first instance as far as possible to the textile, engineering, and clothing trades, certain general principles, common to all trades, however, being also taken into consideration.

In the course of their Report, the Committee point out that the development of industrial operations and the introduction of many new methods of illumination during the last 10 years have served to emphasise the need for statutory requirements relating to the lighting of workshops and factories, similar to those which already exist in regard to heating and ventilation. The recognition that defective illumination may be a contributory cause to accidents, may be injurious to the health and eyesight of workers, and may exercise a prejudicial effect on the output and quality of work, has led to a general interest in the question of industrial illumination.

For the United Kingdom no general provisions in regard to lighting (analogous to those regarding heating and ventilation) occur in the Factory Acts. The appointment of the Committee in regard to industrial lighting thus marks an entirely new departure in this country. The inquiry showed that there has been a great advance in methods of illumination, but various defects were met with which are enumerated in the Report. A statistical inquiry into the number of accidents during each month throughout the year points to the conclusion that inadequate lighting is a contributory cause of accidents. This is confirmed by the evidence of witnesses regarding accidents in foundries, shipbuilding yards, etc. Complaints of eye strain, headache, etc., attributed to insufficient lighting are common, and while an exhaustive medical enquiry would be necessary to establish the connection between these defects and inadequate lighting, there is a general impression that unsatisfactory lighting is, in various ways, prejudicial to health. It is also recognised that insufficient light adds to the difficulty of the proper supervision of work, and of the maintenance of cleanliness and sanitary conditions generally. Witnesses gave specific instances of the effect of improved lighting in increasing the output and improving the quality of work turned out.

Recommendations.

The Committee recommend that:—

(1) There should be a statutory provision:—(*a*) requiring adequate and suitable lighting in general terms in every part of a factory or workshop, and (*b*) giving power to the Secretary of State to make Orders defining adequate and suitable illumination for factories and workshops or for any parts thereof or for any processes carried on therein.

To indicate more precisely what is conveyed by the term "adequate lighting" broadly the illumination may be said to be adequate and suitable provided that:—(i) It is sufficient for the proper carrying out of the work both as regards quality and output, and (ii) there are no lighting conditions prejudicial to the health, comfort and safety of workers. In order to satisfy these requirements, the illumination should comply with the following requirements:—(*a*) Adequacy. (*b*) A reasonable degree of constancy and uniformity of illumination over the necessary area of work. (*c*) The placing or shading of lamps so that the light from them does not fall directly in the eyes of an operator when engaged on his work, or when looking horizontally across the workroom. (*d*) The placing of lights so as to avoid the casting of extraneous shadows on the work.

The next question is the desirability of specifying the amount of illumination implied in the terms "adequate and suitable." Owing to the great progress that has recently been made in the appliances for measuring illumination, it is now practicable to specify numerical values in a manner that would hardly have been possible some years ago. It is therefore proposed to specify the minimum intensity of illumination desirable, from the standpoint of general convenience and safety, in parts of the workshops where work is normally carried on, and in yards, passages and open spaces along which people are ordinarily liable to pass. The following four recommendations are made under this head:—

(2) Over the "working areas" of workrooms the illumination measured on a horizontal plane at floor level shall not be less than 0.25 foot-candle, without prejudice to the illumination required for the work itself.

(3) In all parts of foundries in which work is carried on or over which any person is ordinarily liable to pass, the illumination measured on a horizontal plane at floor level shall not be less than 0.4 foot-candle.

(4) In all parts of factories and workshops (not included under recommendation (2)) over which persons employed are liable to pass the illumination measured on a horizontal plane at floor level shall not be less than 0.1 foot-candle.

(5) In all open places in which persons are employed during the period between one hour after sunset and one hour before sunrise, and in any dangerous parts of the regular road or way over a yard or other space forming the approach to any place of work, the illumination on a horizontal plane at ground level shall not be less than 0.05 foot-candle.

These values are suggested without prejudice to the special illumination required for the carrying out of the work, which naturally varies greatly according to the nature of the operations. At present the Committee are not prepared to recommend standards of illumination for these purposes, which require further investigation.

In Recommendation (6), provision is made for exemption of individual cases, and of factories to which the above requirements could not be applied, and the case of shipbuilding yards is to receive separate consideration.

Finally, in Recommendation (7), suggestions are made for the periodic cleaning of windows.

The Institute of Metals.

The annual autumn meeting of the Institute of Metals, was held on Friday, September 17, at Burlington House, London, W., when the chair was taken by the President, Admiral Sir Henry Oram, Engineer-in-Chief of the Fleet. Abstracts of several of the Papers presented are given below:—

DETECTION OF INTERNAL BLOWHOLES IN METAL CASTINGS BY MEANS OF X-RAYS.

By C. H. Tonamy (Engineer, Mitsubishi Dockyard and Engineering Works, Kobe, Japan).

Though various methods of testing metals have been in use for some considerable time, such as chemical analysis, metallography, and mechanical and physical testing, no method, as far as the author of this Note is aware, has been evolved until quite recently for detecting internal blowholes by external examination. Such defects being, in the ordinary way, only discovered when the material is subjected to machining, the application of X-rays for this purpose seemed likely to be of great service. Particularly is this the case with copper castings, since pure copper, when at a high temperature, absorbs gases from the air, thereby rendering likely the formation of blowholes. When making these castings a small quantity of phosphorus, tin, or zinc is usually added as a deoxidiser. Blowholes, however, are always to be guarded against, and in order to study their occurrence the author made some X-ray experiments upon a thin casting of pure copper, using a Gundelach X ray tube.

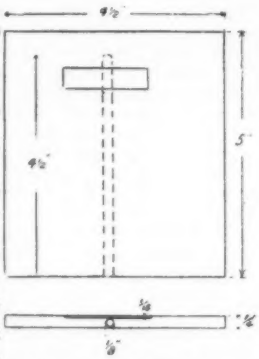


Fig. 1.—Sample of Pure Copper Casting for X-Ray Examination.

The specimen which was used in the experiment was a plate of pure copper, cast at a high temperature. The plate measured 5 in. by 4½ in. by ¼ in., with a hole ½ in. diameter and 4½ in. deep drilled in one side, as shown in Fig. 1. A channel $\frac{1}{16}$ in. deep was drilled on the surface, in order to vary the thickness of the plate. The apparatus used in obtaining the radiograph of the blowholes, drilled hole, and channel is shown in Fig. 2. The specimen was laid on the X-ray plate vertically under the Gundelach tube. By varying the vertical distance, B, between the centre of the tube and the X-ray plate, the time of exposure, and the strength of current, the following results were obtained:—

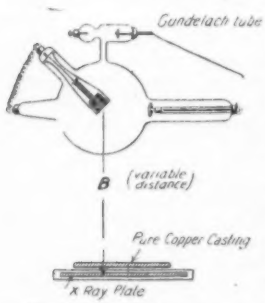


Fig. 2.—Arrangement for Examination.

No. of experiment.	Vertical distance.	Time of exposure.	Strength of current.	Remarks.
	Centimetres.	Min. Sec.	Milliamperes.	
1	50	2 5	0.8	Very faint spots obtained, which indicated the positions of blowholes.
2	30	2 30	0.8	More distinct spots obtained.
3	15	5 0	2.0	Much more distinct spots obtained, together with the radiograph of the hole in the sample.

In order to verify the results so obtained, the plate was sawn across through the indicated positions

Fig. 3.—Side View of Sample Cut by Metal Saw, showing Large Flaw.

of the blowholes, and these were found to be continuous, as shown in Fig. 3.

In this experiment an X-ray source of ordinary strength was used, but had there been employed a much more powerful source, such as the Coolidge tube, used by Dr. Wheeler, the radiographs would certainly have been sufficiently distinct to determine the exact position of the blowholes. Moreover, by taking radiographs in two directions at right-angles to one another, the depth of the blowholes beneath the surface of the plate could be determined.

In conclusion, there is little doubt that useless work in the machine shop might be saved by testing metals by means of X-rays as described above.

SPECIFICATIONS FOR ALLOYS FOR HIGH-SPEED SUPER-HEATED STEAM TURBINE BLADING.

In this Paper, the author, Mr. W. B. Parker, F.I.C., of Rugby, in summarising his conclusions, remarks that it is easier to enumerate the points which should be considered by anyone desirous of improving upon the present supply of blading than to express these in a form which can be considered a specification, because the latter really necessitates the insertion of concrete values for each, and concrete values are influenced by progress in design.

(i.) *General.*—The metal for non-ferrous blading should be in a physically stable condition; that is, either naturally soft or in the annealed state requisite to ensure that it is free from unstable internal stresses.

(ii.) *Proportionality Limit.*—The metal, when in the above naturally soft or annealed condition, should possess a proportionality limit of over 16 tons per sq. in.

(iii.) *Constancy of Proportionality Limit.*—The proportionality limit of the metal in the naturally soft or annealed condition should remain constant within 10 per cent. of its cold value over the whole range of temperature from 100 deg. C. (212 deg. F.) to 400 deg. C. (844 deg. F.).

(iv.) *Maximum Stress (Tensile Strength).*—The maximum stress of the metal in the naturally soft or annealed condition should exceed the proportionality limit by not less than 100 per cent.; that is, the ratio of $\frac{\text{proportionality limit}}{\text{maximum stress}}$ shall be not greater than 0.5. The ratio should remain constant over the whole range of temperature from 100 deg. C. (212 deg. F.) to 450 deg. C. (844 deg. F.).

(v.) *Corrosion and Erosion.*—The metal must be non-corroding and non-rusting in damp steam. It must also resist erosion by steam.

(vi.) *Hardness.*—The greater the natural hardness of the metal in the soft or annealed condition the better, provided it is obtained concurrently with the other necessary properties. The hardness of the best non-ferrous materials now available lies between 10 deg. and 15 deg. Shore's test (scleroscope), so that a new metal having a natural hardness of 30 deg. would be an advance.

(vii.) *Thermal Expansion.*—This should preferably be low, but provided it does not exceed the expansion of the non-ferrous materials now used, it would answer. A metal having a constant co-efficient between 100 deg. C. and 500 deg. C. is desirable, and metals with violent changes of co-efficient due to critical points or ranges should be avoided.

(viii.) *Ductility.*—The ductility, as evidenced by "elongation per cent." and "reduction of area at fracture," need not be great, because it is not, *per se*, of special value. The elongation should not be less than 10 per cent.; the reduction of area not less than 20 per cent.

(ix.) *Specific Gravity.*—The lower the specific gravity of the metal the better; but only if obtained with items ii., iii., iv., v., and vi.

(x.) *Resistance to Vibrating Stress.*—Under certain conditions vibration stresses are exerted on the blading, but the examination of this question is so difficult, that little is yet known regarding them. Until they can be more specifically defined by the designing engineers, it is best to narrow attention down to the other items mentioned.

For a complete research upon selected materials there is required a series of tests which aim at ascertaining the possible value of the materials under working conditions. These can be divided into three kinds, and if a material gives promise in the first two, the third test can be narrowed down to suit specific conditions appertaining to the design of any turbine.

(I.) *Stress and Time (duration of stress).*—A series of tension tests at ordinary temperature, with loads ranging from a ton or so below to a couple of tons beyond the proportionality limit with variation of duration of the stress. If the metal is only for use in the low-pressure and temperature end of the machine, this test gives useful data, and may suffice.

(II.) *Stress and Temperature.*—This is a series of tension tests at increasing temperatures, but including the proportionality limit determination for each temperature. It serves to detect any weakening due to the effect of short durations of increased temperature.

(III.) *Stress, Temperature, and Time.*—This series can be limited to particular problems of design. It correlates the effect of a specific duration of a specific range of stress at any specific temperature. It should include the determination of the proportionality limit for each set of conditions.

To prevent manufacturers being discouraged by the above array of tests, it may be stated that only very promising materials need be put through the whole of the above research scheme. A rapid sorting out can be effected by a short scheme, such as accurately determining the maximum stress, proportionality limit, modulus of elasticity, elongation, and reduction of area upon cast materials thus, use: (1) Dry sand cast bars of the material, having a cast section of not less than 1⅛ in. diameter. If these give good results, then (2) repeat the tests upon a similar bar after annealing it for four hours at 500 deg. C., and cooling so slowly that it is in the natural soft condition.

If a good proportionality limit is obtained for the annealed casting, and the other properties are not lowered below the allowable minima, proceed to roll, draw, or otherwise work the metal into sections of preferably ½ in. diameter or ½ in. by 1 in. flats, and anneal these so that they are in the natural soft condition. Then, using these—(3) Determine the same physical values as in (1) and (2). If the tests are still satisfactory, then thoroughly test it according to the larger scheme, either entirely, or Parts II. and III.

If the structures show what can be termed imitations of steel structures—especially of the pearlitic structure—they probably possess a naturally good proportionality limit. In fact, the author believes that by striving to find non-ferrous materials which naturally have steel structures, the naturally strong alloys now in demand will be discovered.

Having now, for reference purposes, a statement of the nature and present position of the turbine blading problem, it is for the non-ferrous trade to bring forward the material and to recover the ground they have lost to the steel trade; but it should be noted that only materials which have been fairly completely investigated by its advocates upon the lines named above, and which really give promise of improvement, will be welcomed by turbine makers. Frank exchange of test data is desirable, for turbine makers are not in business to test anything and everything which the brass manufacturers think original and an improvement.

CORROSION OF GUNMETAL.

A Paper was presented by Messrs. Cecil H. Desch, D.Sc., Ph.D., and Henry Hyman, B.Sc. (Glasgow) on "The Micro-Chemistry of Corrosion. Part IV. Gunmetal," in which the authors remarked that the corrosion of gunmetals had been examined by the electrolytic method previously used for the brasses. It was found that the rate of corrosion and the relative resistance of the different constituents varied greatly with the applied electromotive force, and also with the state of the surface. So marked was the effect produced by the flow of the metal in polishing, that it was found necessary to remove the flowed surface by light etching in order to obtain comparable results. The influence of tin was very strongly marked, on account of its property of forming a layer of basic salts which adhered and formed a protective varnish. An alloy containing 14 per cent. of tin was corroded less rapidly than one containing 10 per cent. Annealing, by rendering the structure coarser, increased the corrosion. A pure alpha alloy was corroded more than one which contained eutectoid, but the presence of the beta constituent, in quenched specimens, was without marked effect, the difference between alpha and beta being comparatively small. With very small currents the eutectoid was almost unattacked, but as the current was increased it was attacked more and more rapidly. With large currents the differences between the alloys were largely obliterated, owing to the rapid formation of a tough, adherent skin.

CRYSTAL TWINNING BY MECHANICAL STRAIN.

Professor C. A. Edwards, D.Sc. (Manchester), discussing "Metallic Crystal Twinning by Direct Mechanical Strain," said that during the last few years considerable attention had been given to the question of crystal twinning in metals and metallic alloys, but there still appeared to be some doubt as to whether structural changes of this kind could be produced in metals without subjecting the mass to some kind of annealing operation. The author, on this subject, disagreed with Dr. Rosenhain, the latter considering that it had still to be proved "that twinning could occur in all metals by direct straining."

In the present Paper Professor Edwards does his best to satisfy Dr. Rosenhain and others on this point, marshalling the results of his own and other investigators' recent experiments in such a way as to bring him to the conclusion that "all the evidence available goes to prove that twin crystals can be formed in metals by direct mechanical strain." He presents numerous geometrical drawings, as well as photomicrographs, to illustrate the movements in mechanical twinning of metallic crystals, movements which make it "perfectly logical to consider that amorphous layers are produced on the twinning planes." The reply of the "non-twinners" will be awaited with interest.

THE COPPER-RICH KALCHOIDS.

"Notes on the Copper-Rich Kalchoids," formed a Paper by Professor Samuel L. Hoyt, Ph.D. (Minnesota, U.S.A.), and Professor Paul H. M. P. Brinton, M.Sc. (Arizona, U.S.A.). Professor Hoyt presented at the Ghent Meeting (1913) of the Institute of Metals a fine piece of work on the constitution of the copper-tin-zinc alloys, or kalchoids as they may be shortly termed. The present Paper is a continuation of that work, and consists chiefly of a thermal and metallographical analysis of those alloys lying particularly within the alpha field. The main object of the investigation is to determine with greater accuracy the temperatures of the heat effects. The information thus derived is used to assist in the explanation of the heat effects of 520 deg. C. and 590 deg. C., and the accompanying structural changes.

CONSTITUTION OF BRASSES CONTAINING TIN.

In a Paper by Messrs. O. F. Hudson, D.Sc., and R. M. Jones, M.Sc. (Birmingham), on "The Constitution of Brasses Containing Small Percentages of Tin: A Contribution to the Study of the Ternary System, Copper-Zinc-Tin," the authors describe work carried out with the object of determining the equilibrium constitution for ordinary temperatures of the ternary alloys containing between 50 and 70 per cent. of copper and 0.5 per cent. of tin. Some fifty alloys coming within these limits of composition were prepared and analysed. Specimens of these alloys were subjected to long annealings—in some cases as long as 15 days—below the lowest known critical temperature, and the structures observed under the microscope were noted. From the results of these experiments a constitution diagram has been constructed and is given in the Paper. Most of the alloys represented in this diagram belong to one of two classes, viz.:—(1) Those which have the ordinary constitution of the copper-zinc alloys, the tin being held entirely in solid solution, and (2) those in which a constituent resembling the δ of the copper-tin alloys is present. In alloys of the first-class the amount of tin which can be held in solution is nearly 2 per cent. with 70 per cent. of copper, and decreases to about 0.5 per cent. with 64 per cent. of copper, the alloys consisting entirely of α. With further decrease in percentage of copper and the appearance of the β^1 constituent the solubility of the tin increases up to about 1.75 per cent. at 55 per cent. of copper when the alloy consists almost entirely of β^1. With tin in excess of these limits the δ constituent makes its appearance, the alloys consisting either of $\alpha + \delta$ or of $\alpha + \beta^1 + \delta$, according to their composition.

INDUSTRIAL BRASSES.

Mr. D. Meneghini, Ph.D. (Padua, Italy), presented two Papers, on (1) "Structural Changes in Industrial Brasses," and (2) "Hardness of Copper-Zinc Alloys." In the first he deals with breakages of brass incandescent gas burners that have occurred in regular use. The burners are shown to become very brittle in use, their fragility being explained by the presence of β or of γ identified in several brittle samples. This is probably due to the great differences in the mechanical properties of alloys consisting of solutions of α, β or γ, there arising, as a result of the work done upon the alloys, internal strains which can attain very high values. These strains are also liable to result from reactions due to local heating during use. Such heating is often occasioned, Dr. Meneghini shows, by burners "lighting back." The action of electrolytes resulting from the latter process is discussed. In his second Paper Dr. Meneghini describes the apparatus he used in the determinations of hardness made in order to ascertain the extent of cold working or incomplete annealing in the gas burners referred to in his first Paper. A very interesting table is also given showing the results of nearly 30 hardness experiments on copper-zinc alloys. The alloys with zinc between 55 and 68 per cent. were very hard and brittle, being most difficult to work. Those containing 78 to 88 per cent. of zinc were in places very porous, and only in the case of samples containing 84 to 87 per cent. of zinc was it found possible to obtain a specimen sufficiently homogeneous for making a hardness determination.

PHYSICAL PROPERTIES OF METALS AS FUNCTIONS OF EACH OTHER.

Discussing "The Physical Properties of Metals as Functions of Each Other," Mr. A. H. Stuart, B.Sc., gave in the first part of his Paper a critical analysis of the law of Dulong and Petit. Twenty-five metals had been considered of which eleven deviated from the "law" by an amount which could not be attributed to experimental error. The error in such cases, however, appeared to be a function of the atomic weight. In the latter part of the Paper the atomic weight was expressed as a function of the density, the modulus of elasticity, and the co-efficient of linear expansion, the form of the equation being:—

$$\text{atomic weight} = 1.41 \left\{ \frac{\text{Density}}{\text{E} \times \text{Coeff. of lin. expans.}} \right\}$$

E being expressed in kilogrammes per square millimetre, density in grammes per c.c., and the co-efficient of expansion in Centigrade units. Lastly, the amount of cooling which takes place in a bar of unit length and section when submitted to a longitudinal stress p, at absolute temperature T (the deformation being purely elastic), is shown to be given by

$$-\Delta T = \frac{T}{19\,E.}\ \Delta p$$

Functions of Sand Binders.*

By H. M. Lane.

In foundry practice a sand binder is that agent which holds the grains of sand in the body of a mould or core in place when the metal is introduced into the mould. The binder must be of sufficient strength to hold the sand rigidly until the surface of the metal has solidified to form a protective skin, and at the same time must be of such a nature that it will release the sand grains after the casting is set, so that the sand can be cleaned off with the greatest possible ease.

Dry-sand moulding, skin-dry work, green-sand moulding, dry-sand cores, and green-sand cores, merge into one another so closely that it is impossible to separate these classes by any distinct lines of division, hence the subject of binders may be considered in relation to sand regardless of whether the sand forms the body of the core or mould.

There is one point in regard to binders that should be made plain at the beginning, and that is that binders exert two different influences at different points of the moulding or core-making operation. In the case of dry-sand moulds and cores, it is necessary to have something to hold the body of the sand in shape previous to and during the drying process. The agent used for this purpose is commonly known as a green binder. In the case of green-sand moulds and cores the green binder only is required.

Classification of Binders.

There are a good many ways in which binders can be classified, but probably as good a general classification as we can find is to divide them into water-soluble binders, paste binders, colloids and allied bodies, and gums, pitches and oils. The first two classes are all subject to moisture, and cores made from them are likely to soften if exposed to moisture. The colloid bodies may or may not be subject to injury from moisture, while the gums and pitches are as a rule water-resisting or water-proof.

Under the heading of water-soluble binders there are molasses, sour beer, distillery refuse, paper-mill waste products such as glutrin, corn syrup waste products such as hydrol, glue and silicate of soda.

Under the paste class there are three general types known as flour, starch and dextrine. The flour includes wheat and rye flour, fine ground white corn used as an adulterant for wheat flour and pea meal. Under the starch class we have corn starch, wheat starch and potato starch. Dextrine is made from starch and gives a stronger paste than the other starches used.

Under the oil class there are at the top of the list milk of lime, alumina compounds and iron compounds or combinations of these. The binding power of horse manure or cow manure is due to the colloidal nature of some of its ingredients, and also to the reaction which it has with the clay which serves to increase or support the colloidal condition of the clay.

Under the gum class there are resin, pitch obtained from the distillation of coal in making illuminating gas, or tar from gas producers, pitch from the destructive distillation of wood, and various kinds of asphaltum or pitches from petroleum products.

Under the oil class there are at the top of the list the drying oils, which are headed by linseed oil and chinawood oil. The iodine number of an oil as taken in the paint trade forms a very good index as to their binding properties. This class includes whale oil, and various fish oils such as manhadden oil, soyabean oil, cotton-seed oil, sun-flower seed oil, and a large variety of oils of vegetable origin.

Next are the filling oils which are used largely as adulterants with the drying oils. There are four general sources for this class of oil. First, the class known as neutral oils which come from petroleum. Second, the tar oils which come from the ordinary rectification of gas-house tar. Third, a small class of oils which are made through a destructive distillation of certain coal or shale products, which are produced in small quantities for the paint trade. Fourth, resin oil which is made from the destructive distillation of resin. There are also oils from the destructive distillation of wood.

The action of the various binders mentioned have considerable to do with their sphere of usefulness. It may be wise first, however, to consider something of the different conditions to be met by sand binders.

Binder Requirements.

When casting aluminium we are face to face with a very light metal which sets quickly after pouring, and which has hot-short tendencies. The fact that the metal is light, or of low specific gravity, results in the moulds not being subjected to serious pressure from the head of the metal during the pouring. Its quick setting and low pouring temperature protects the sand from great heat, and at the same time gives little available heat to burn out or reduce a binder. Its hot-short tendencies make it necessary to have a core which will crush readily. This means that for this type of work must be used either a soft, pliable moulding or core-making material such as a soft green-sand mixer, or a binder must be employed which softens immediately upon exposure to heat so that it can give way before the shrinking metal. The latter conditions are met by the use of resin, and to some extent by pitch.

High phosphor-bronze is a metal with great searching power, *i.e.*, it is so fluid when molten that it has a tendency to flow in between the sand grains themselves. This character of metal calls for a core with a very tight surface, which is not very readily penetrated with the metal. This is accomplished by the selection of a grade of sand having fine grains of a comparatively uniform size with possibly the addition of some surface finish to the core or mould.

Ordinary grey cast iron is a metal that sets much slower, and is so heavy as to have a serious lifting effect, which tends to strain or change the shape of the mould, or to displace cores. Cores for this metal necessitate a much stronger material than would be required for aluminium, but at the same time there are available many more heat units per cubic inch of molten metal, and this tends to disintegrate or break down the binding material so as to soften the core.

With steel the same conditions exist as with grey iron, except that one must be careful in the selection of moulding sand, core sand, etc., to avoid all fusible ingredients.

* Paper read before the Annual Meeting of the American Foundrymen's Association, September, 1915.

Action of Binders.

In the water-soluble class of binders, molasses binds by boiling up, and then hardens. It is this boiling of the molasses just before the final set that has a tendency to deform molasses cores. Thus far certain brands of cane-sugar molasses have been found best for core-making. Some years ago the writer carried on an extensive series of tests to ascertain the relative advantages of different forms of molasses and the effect of fermentation on the binding power of this material. The results of these tests proved conclusively that there is a wide difference in the binding power and that fermentation in any given grade of molasses would destroy over half of the binding power. In this series of tests some interesting results were obtained from beet sugars or beet syrups. The cores made with these materials as a binder, when first baked, were of excellent strength, but they were unsatisfactory in that they would draw moisture from the atmosphere and fall to pieces on the slightest pressure. This is found to be due to the presence of certain salts in the molasses, particularly potash and soda.

Sour beer owes its binding power largely to the presence of dextrine and similar ingredients, and this also is true of distillery refuse. The ingredients present which have not been converted into sugar and then changed to alcohol act as binders.

Glutrin binds in a very different manner from molasses. With absolutely sharp sand it has a tendency to follow the water to the surface, giving a hard skin next to the metal and a core with a soft interior. The introduction of clay or any other colloid will tend to hold the glutrin in the body of the core, which greatly increases the strength and gives a uniform structure throughout. Glutrin, like oil, draws down to the contact points of the sand, thus giving a far greater efficiency per pound of material than is obtained with many other classes of binders.

Glue, like glutrin, draws to the contact points, and gives good results, but it emits disagreeable odours during pouring and is subject to serious fermentation difficulties.

Hydrol is a residual product obtained from the corn-sugar industry, and it binds much like molasses, though with less tendency to bubble. However, it has quite a tendency to absorb moisture, in this respect being more like the beet syrups.

Silicate of soda has not proved successful as a mould or core-sand binder, on account of the fact that it does not realise readily when the metal is poured into the mould—in other words, when it is exposed to heat.

Paste Binders.

Taking up the paste class, under flours, wheat flour is the most efficient on account of its large percentage of gluten. Other flour compounds are efficient in proportion to the amount of gluten or sticky material which they contain. Rye flour is never as efficient as wheat flour, and while ground white corn can scarcely be differentiated from wheat flour by ordinary chemical analysis it has practically no binding power. Pea meal, which is used in some sections, has relatively little binding power, and middlings or other similar products are only efficient in proportion to their amounts of gluten of sticky material.

Under starch, is found a peculiar class of binders. This material is generally used in the uncooked state, in which condition it acts as a paste. All paste, whether flour or starch, binds in a purely mechanical way, that is, the particles of binder are distributed among the sand grains, and ordinarily dry at the point where they are left. If the paste particle happens to bind two grains of sand together it becomes efficient, but if it happens to occur between sand grains in the open spaces it adds nothing to the strength of the core and only tends to close the vent space. When starch is cooked or treated chemically in such a way as to make a liquid paste, it becomes a binder which behaves more like oil in that as drying progresses it draws back toward the contact points of the sand, thus giving better binding action.

Dextrine is a derivative from starch, having more binding power in the uncooked form than starch.

Oil and Clay.

In the group of colloids, we find that clay, which is the natural bond of moulding sand, plays an important part in foundry practice. In order to develop fully the binding properties of clay, it must have undergone the process commonly known as weathering. It was formerly considered that it was simply the water from decaying vegetation that effected this change, but it is now recognised that bacteria probably play an important part in the changes.

As already stated, there are reactions between these natural binding materials which the chemist calls colloids, and there are also reactions with the various binders used in sand. Flour, starch and dextrine work in harmony with clay. This is also true of most of the water-soluble binders, but all of the oil binders act in opposition to clay. The clay first absorbs as much oil as it can, thus taking it away from its legitimate use as a binder, and at the same time the oil destroys the binding power of the clay.

Particularly in steel foundry practice there are some silica sands in which magnesia plays an important part as an active binding material, and there are cases in which milk of lime or other chemical compounds have proved useful, but this group has not received much attention from foundrymen.

Gums.

We now come to the class of gums. In this class resin stands by itself. When powdered resin is mixed with sand as a binder it melts during baking, and flows between the sand grains. Upon cooling, the resin acts as a binder. For this reason resin cores are known as hot-soft cores on account of the fact that when the resin is hot it has no binding power.

If rosin, in a mass, is heated to 645 deg. Fah. at ordinary pressure, it is decomposed into resin oil and resin pitch. At this temperature the elements which compose the material re-arrange themselves into different forms with radically different chemical properties. Resin oil has been used as an adulterant for core oil. It, however, has a very small percentage of the binding power present in the original material. When a resin core is exposed to the molten metal the resin is decomposed, and the resin oil passes off as vapour. Between 80 and 90 per cent. of the resin passes out in this way, and the result is that when resin cores are used with any metal having sufficient heat to decompose the resin, easy cleaning conditions prevail. The vapours from the resin which condense on the red-hot surface of the interior of the casting undergo a second decomposition with the deposition of free carbon, which gives the castings a beautiful, glossy black surface.

The other members of the resin family include all of the varnish gums and the different ambers, but these materials are too expensive to use as core binders.

Black Compounds.

The so-called black compounds are usually made from rectified pitch which comes from the distillation of coal tar. These tars generally carry about 50 per

cent. of fixed carbon, or in other words give 50 per cent. of very hard coke. For this reason they vary greatly from resin. During the baking of the core the pitch melts, flows between the sand grains, and binds the material, in this way acting like resin, but during the casting process a relatively small amount of volatile material is driven off and hence a much larger percentage of coke is left behind. Then, too, this coke has a very hard nature, and frequently makes the core stronger after the metal has been cast around it than it was before it was put into the mould. This coking explains the rebaking effect frequently referred to by foundrymen.

Oil Binders.

Coming to the oil binders, two general divisions are encountered. The first represents the drying oils of the paint class. With a true drying oil the binding power is developed, not by the evaporation of something from the oil, but by the oxidation of the oil itself so that the binder in the core, after baking, weighs more than it did before baking. The difference, however, is very slight and amounts to an increase of approximately 1 per cent. of the weight of the binder, and as in this class of cores the binder is used in the ratio of 40 to 80 parts of sand to one part of oil, it will readily be seen that this increase is so small it would not be noticed in the final results. Also, it is more than counterbalanced by the expulsion of moisture from the sand. With the drying oils, as the moisture is driven out, the oils draw between contact points of the sand, and then harden. The drying of good oil is hastened by adding what is known to the paint trade as dryer. The chemist calls this a catalytic agent or something which has the power of causing changes without itself being changed. For example, certain manganese salts have the power of extracting oxygen from the air and giving it to the oil in such a way as to cause a much more rapid oxidation than could be caused by air alone. With a good drying oil the atmosphere of the oven is a very important factor in the rate of drying, and there must be a positive circulation of a proper amount of oxygen.

It has already been mentioned that linseed oil and chinawood oil head the list of drying oils. The latter also contains a natural drier.

The other general division of the oil class covers that type of oil which dries down to a sticky residue that forms the binder. Some of the natural asphalt-base petroleum oils act in this manner, and in fact any oil from which a certain amount of volatile constituents can be driven out to leave a high melting point tar or pitch may be placed in this class. Also in the same class are the oils made by dissolving a gum or resin in a petroleum product or neutral oil.

In order to cheapen some oils, many manufacturers introduce a certain percentage of resin dissolved in petroleum oil. Such an addition, however, slows down the drying action of the drying oil as it tends to exclude the oxygen from the oil at the critical point in the drying process, and oil of this kind really becomes a varnish and it is only by the addition of artificial driers that rapid drying can be effected.

Some of the oils belonging to this latter class will stand more abuse than other core oil on account of the fact that some of the pitches are not broken up readily at ordinary temperatures, and would resist a temperature of 500 or 600 deg. F., finally coking, and still act as a binder provided the temperature did not go high enough to burn them with the oxygen present.

In many cases in the core-oil trade the core-oil maker has discovered that deficiency in oven design can, to a certain extent, be made up by using certain types of oil binders of the class last discussed, and hence he supplies an oil suitable for these ovens and later the foundryman improves his oven conditions and then cannot understand why the cores do not come out the same.

With properly designed ovens, and cores made from sharp sand and oil, some one of the high-priced drying oils has always been able to contend with all of the cheaper products of the dissolved-gum class, but the sand must be properly mixed, and in many cases iron traps or core pans are necessary to support the cores during baking.

Core-drying practice, as it exists in most foundries, is simply a compromise, one set of conditions being juggled to meet another.

Coal for Air Furnaces.

In the course of a Paper on "Coal—Its Origin and Use in the Air Furnace," before the American Foundrymen's Association, Mr. F. Van O'Linda discussed the coal best adapted for air-furnace use, and suggested that it should be low in phosphorus and sulphur as well as ash, be high in volatile matter, and burn with a long flame. The author continued:—When firing, it is preferable to throw the coal directly on to the fire instead of coking it in front of the door, and since during the first three or four minutes the coal is giving off its heavy gases, plenty of air should be admitted at this time. If possible, the bottom wind should be partly cut off after these heavy hydro-carbons are driven off, because otherwise the excess air will pass through the furnace and out of the stack, taking heat with it. No advantage is to be obtained from coking the coal before spreading it on the fire, thereby making two operations of one. Coal should be spread from the shovel when firing, but if coke is desired, why not fire coke in the first place? Air-furnace melting requires flame, and coke is a short-flame fuel. I cannot agree with those who claim that radiation plays an all-important role in the air furnace. It has its part in the melting operation, but flame is absolutely necessary, or otherwise low-volatile smokeless coals which give off great heat, but little flame, could be used. Some furnaces will melt satisfactorily, but are slow in heating the iron, and in almost every case this is due to a short flame or to the flame passing high in the furnace and not sweeping down upon the bath.

Too much coal should not be fired at one time; three or four shovelfulls spread on the fire every three minutes give good results, as the practical banking of a fire by covering up all the incandescent coal gives a heavy, smoky flame, with low available heat value. For the complete combustion of each pound of coal, 15 lbs. of air are required, and with small, frequent firing, the coal and air supply are more nearly equal. The placing of the top blast inlet is important. If the pipes point directly down into the furnace, the air forms a screen through which the flame has to break. The pipes should be so placed that the blast follows the course of the flame and becomes a part of it. When the flame is held low in the furnace it will cut through the pig-iron and sprue during melting instead of hurdling over it. The heat also will be shortened, for the flame will hug the iron, causing it to heat quickly and at the same time it will cover the bath and prevent oxidation. The phosphorus and sulphur content of the coal should be low. While sulphur has considerable heat, it is an element to be avoided in air-furnace practice. Ash is the non-combustible residue left when the fuel is burned. Some coals show less than 3 per cent., while others may contain as high as 15 per cent. of non-combustible matter.

The Micro-Structure of Type Metal.

By James Scott.

Type metal generally consists of an alloy of antimony, lead, and tin. Occasionally, copper is mixed with antimony and lead; but the most widely used ingredients are those named. The respective proportions vary, but a favourite composition is two parts of antimony, eight to eleven parts of lead, and one part, or less, of tin.

Both lead and tin are easily fusible; but antimony requires a much higher temperature to melt it. Antimony is very hard and brittle, being like bright

FIG. 1.—MAGNIFIED PIN-HOLE VIEW OF TYPE METAL; CRYSTALS ARE MOSTLY ANTIMONY.

silver or tin in colour. Its structure is what is known as lamellar—*i.e.*, it consists of a mass of thin crystalline plates lying over one another in dense compactness. In viewing its surface one can see various geometrical and curved flaky patterns formed in very fine lines, which indicate the borders of the plates. The metal can be easily crumbled to pieces by means of the finger nails. For type metal it benefits lead and tin because of its curious property of expanding during the cooling and solidification processes. Antimony by expanding fills up every minute corner, edge, and crevice of the mould.

For printers' type lead alone would be much too soft; antimony alone would be too brittle and have a definite tendency to snap. Tin, also, would be too soft and yielding, if used without any companion metal. By a proper combination of the various merits characteristic of the respective substances, however, an excellent type is produced. Great care has to be exercised in preparing the alloys because of the different melting points of the three metals. Estimations differ slightly on this subject; but they can be regarded as follows:—Antimony melts at about 450 deg. C.; lead at about 328 deg. C.; and tin at about 232 deg. C. These matters have to be considered during the melting and mixing of the type alloys. The temperatures at which cooling begins also naturally differ.

Although an alloy is often regarded as an actual amalgamation or chemical blending of the metals, it more often consists of a neat, coherent mixture. That is to say, however intimately the elements are compounded together they generally resolve themselves, as they cool and harden, into clusters of crystals of various sizes. These objects can be readily identified, and can be made to respond to the actions of acids dropped in small quantities upon them, thereby producing salts. Excellence of blending, or alloying, depends on the fineness to which the component parts are reduced. If a molten mass of antimony were poured into a molten mass of lead, and left to cool without further attention, each would form a lump by itself, and there would be a gradual blending at the parts where they meet. Most of each metal would solidify alone; but at the junction would occur an alloying, the extent of which would depend on the amount of heat present, and the length of time it operated. One metal would properly combine with another up to a certain point; but beyond that there would be evident a less perfect settlement, grading away into an actual isolation of each metal. When, however, the molten metals are carefully united, and the continuance of heat and so on is properly supervised, one is dispersed so thoroughly throughout the other that the minute particles, upon cooling, are found to be satisfactorily blended.

The alloys, when carefully submitted to remelting processes, naturally become finer and more consolidated. Much care is, however, required during such operations, for it is possible for some of the antimony, for instance, to seggregate—*i.e.*, combine into

FIG. 2.—MAGNIFIED VIEW OF TYPE METAL WHICH HAS BEEN IMPROPERLY ALLOYED.

irregular disposed clusters instead of being uniformly scattered. The same thing is possible in the first melting, but remelting is often undertaken by men who buy the freshly-made alloys from the foundry; and these may not be quite so experienced as the original producers.

Oxidation is the bugbear of type founders. This term signifies that oxygen combines with the metallic

element. This gas can be obtained from the heat of the furnace and the air; and is responsible for the appearance of dross in the alloys. When antimony is strongly heated it yields two forms of crystals, a needle or prismatic form and octahedra. The latter are shown in Fig. 1, and are eight-sided objects resembling two four-sided pyramids placed base to base. They can be easily modified into cubes. When shorn of their extremities they become squares.

When lead is oxidised it forms a granular mass, either grey, yellow, or red, according to the extent of the change. The latter is red lead.

Tin does not readily oxidise. It will crystallise in curious figures even by the motion and friction of fracture; but the designs do not exhibit any particular geometrical boldness.

It often happens that owing to some fault—impure elements, careless heating or cooling, and so on—granulation and crystallisation goes wrong. Overheating, which is synonymous with oxidation, often causes a kind of filigree or irregular branching of the elements, as in Fig. 2, instead of a compact amalgamation.

The metallic alloys which the writer microscopically examined for the purpose of this article were pieces of ingots which were broken so as to show the internal structure, as well as allowing some of the smooth surface to remain. That used for ordinary type was comparatively coarse, and showed to the naked eye a distinctly granular glistening fracture. The alloys intended for use in connection with linotypes, monotypes, and stereotypes were much finer in grain, the latter being particularly so. The crystals were very much smaller than those in the ordinary type shown in Fig. 1.

All these metals readily took on a neat polish. This attribute is one of great importance, because it admits of obtaining level surfaces on the type. When the alloy is perfectly smooth the granules and crystals form an almost undetectable pattern, so closely are they set. In the ordinary surface, which may appear to be even, they rise above surrounding minute depressions, and so stand in relief.

The Iron and Steel Institute.

The autumn meeting of the Iron and Steel Institute was opened at the Institution of Civil Engineers, Great George Street, Westminster, on Thursday, September 23, Mr. Arthur Cooper (Immediate Past-President) in the chair.

The CHAIRMAN, in opening the meeting, alluded in sympathetic terms to the serious illness of the President (Dr. Greiner), who has been suffering from enteric fever. After quoting from a letter that he (the Chairman) had received on the previous morning from Dr. Greiner's brother reporting rather more favourably on the President's condition, he remarked that he was quite sure the very sincere sympathy of the members would go out to the President, with an expression of the hope that he might soon be restored to health.

Mr. Joseph Hill (Derby) and Mr. Hugh Savage (London) were appointed scrutineers for the examination of voting papers for the election of new members of the Institute, and it was subsequently announced that all the candidates had been unanimously elected.

The SECRETARY announced that, in accordance with Rule 10, the following was the list of Vice-Presidents and Members of the Council who were due to retire in rotation at the annual meeting in 1916:—*Vice-Presidents*: Messrs. C. P. E. Schneider, Andrew Lamberton, and P. C. Gilchrist. *Members of Council*: Messrs. J. C. Cuninghame, Gustave Trasenster, Edward Steer, Francis Samuelson, and M. Mannaberg. All were eligible for re-election at the next annual meeting if no further nominations were made in the meantime.

The CHAIRMAN recalled the resolution passed at the last meeting on the question of alien enemy members. In consultation with the solicitors of the Institute, the new rules for addition to the existing bye-laws, which were printed in the notice convening the meeting, and which the solicitors approved, were proposed for adoption. It was open for any member at the meeting to propose amendments to the new draft bye-laws.

The SECRETARY read the new rules for addition to the existing bye-laws, which appeared in our last issue.

MR. GEORGE HATTON asked, with reference to the proceedings at the last meeting of the Institute, whether the alien members were removed from the list by the Council or by resolution of the Institute generally. He thought it was by resolution of the Institute generally, and that being so he desired to propose the following amendment to Rule (1), namely, that the last sentence, "but they may, if the Council thinks fit, be reinstated after the termination of the war" be deleted, so that any alien member who might ultimately again become a member of the Institute should do so by the ordinary course of election to the Institute.

The CHAIRMAN said those present would remember that the resolution passed at the last meeting was, "That the names of all alien enemy members be struck off the list," but that could only be done subject to the advice of the solicitors. Every step that had been taken had been taken on the advice of the solicitors. The Honorary Members and the Honorary Vice-Presidents were regarded as struck off the list the moment the resolution was passed, but with regard to the ordinary members they were really members till December 31 of the present year. They would not get the "Proceedings," nor any of the advantages of the Institute; and on December 31, when they would be in default with their subscriptions, they would automatically be deleted from the list of members.

MR. HATTON said that was satisfactory so far as the process of removal was concerned, but if the alien members were to be reinstated by a vote of the Council they would simply be relieved of their subscriptions for the period of the war, two or three years, and would then come back again as members of the Institute.

The CHAIRMAN enquired whether the following suggestion, which had been made to him by Mr. Williams, would meet Mr. Hatton's view, namely that the last sentence of No. (1) should be deleted and the following words substituted: "But they shall be eligible for re-election in the usual way."

MR. HATTON agreed.

The SECRETARY read the amended bye-law as follows:—"(1) In the event of a state of war existing between Great Britain and any other country or State, all members, honorary members, and honorary vice-presidents who shall be subjects of such enemy country, or State, shall forthwith cease to be members, honorary members, or honorary vice-presidents of the Institute, but they shall be eligible for election after the war in the usual manner."

This was agreed to, and it was announced that the alteration would be brought up for confirmation at the annual meeting to be held in May, 1916.

Pulley Moulding by Machine.

By Joseph G. Horner, A.M.I.Mech.E.

Pulleys made as solid patterns, *i.e.*, those in which arms and rim are in one piece, but jointed, of course, through the middle of the arms, are moulded by machine. Patterns of iron only are understood, those of timber being unsuitable for any length of service. But unless very large numbers are required off a pattern of one diameter and width and bore, no advantage is gained by making use of a solid pattern, by comparison with the loose rim and arm system. In highly-standardised and permanent work it may be adopted but not in other cases; and even for that it is not desirable. If the pattern rim is well tapered

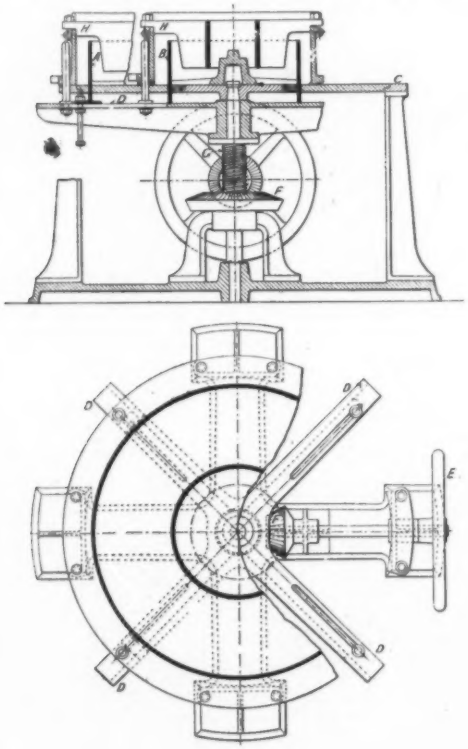


Fig. 1.

inside and out, a moulding box can be lifted off from it by the mechanism of the machine with some slight risk of fracture of the sand. But using stripping plates, the loose pattern rims of nearly parallel thickness are drawn down from the mould through the stripping plates with no risk whatever. The following remarks therefore have reference to this method, and to the pattern parts and machines which are employed in the production of pulley castings. It is a system which is equally adapted for occasional or for repetition work, and for pulleys with single or with double arms, and made either solidly or split. But even here provision is made in the machines for lesser and higher degrees of specialisation. In the first an outfit of pattern rims and arms is made distinct from the machines; in the second the pattern rims are actually built into the machine, and either one is brought into service on the setting of a pointer. Naturally the range of the capacity of any one machine is limited, but the units can be multiplied as

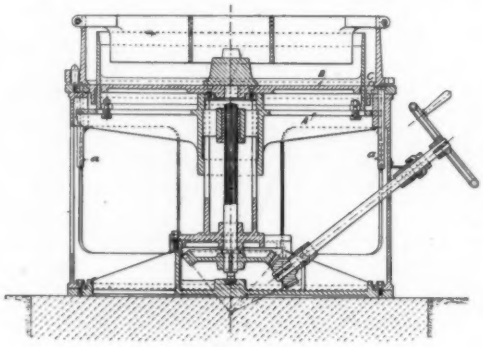


Fig. 2.

the extension of business demands; and the first-named kind of machine has to recommend it, the fact that spur-gear patterns can be moulded upon it. The ramming is done in all cases by hand, but the withdrawal of patterns and the lifting off of the moulds is by geared mechanism, easily operated. We will take the simpler machine first.

The pattern units required are a pulley rim provided with a flange and lugs for screwing it down to

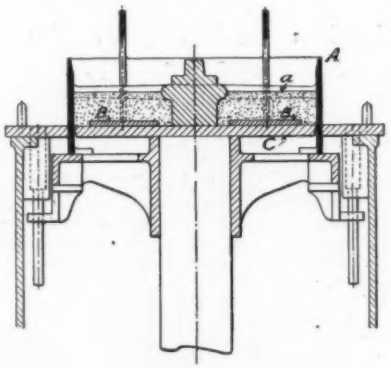


Fig. 3.

a cross, through the medium of which its withdrawal is effected; also two stripping rings, an outer and an inner one, between which the pattern ring is drawn downwards. The outer ring is plain, the inner one carries the half thickness of arms and boss. The two are mounted on separate plates.

In moulding, the rim pattern is set at the required height, which is equal to half the depth of the cast-

ing. The flask, either drag or cope, is set in position over it and rammed. After ramming, the rim is withdrawn downwards through the stripping rings. Then the box is pushed upwards by means of adjustable lifting pins and is carried away. The moulding of the second half-box is a repetition of that of the first. When the pulley has straight arms no change is made in the pattern. But if the arms are curved, two half-sets are wanted for right and left curves, replaceable on the inner stripping ring. Any depth

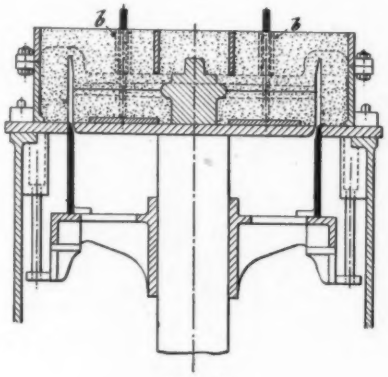


FIG. 4.

of pulley can be moulded up to the limit of width of the pattern rim. The types of machine employed in this loose-pattern system are illustrated.

The limitations as to diameter of any one machine just now referred to are shown in Fig. 1, the largest and the smallest pulleys which it will carry being shown at A and B respectively. This machine is

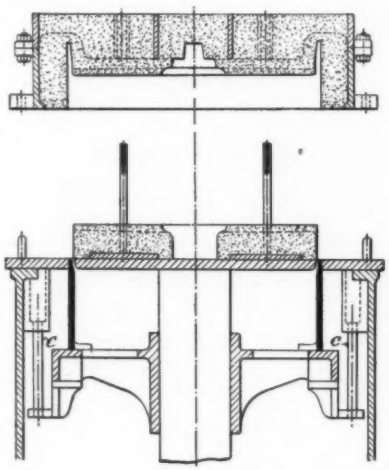


FIG. 5.

made in three sizes. In the smallest the diameters range from 8 in. to 24 in., in the largest from 24 in. to 60 in., in the intermediate size from 12 in. to 39½ in. The moulding box is carried on a level with the table C, within which table the outer stripping ring is carried. The cross arms D receive the pattern rim bolted to them, having bolt slots long enough to accommodate the whole range of rings. The arms and rim are lowered or raised by the handwheel E actuating the bevel gears F, and screw G. The handwheel controls both the movement of withdrawal of the rim downwards, and the lifting off of the flask immediately following, by the reversal of the direction in which the handwheel is turned. The flask is lifted on pins in the cross, which are adjusted to give the proper amount of lift to the flask. The handwheel also regulates the distance by which the pattern rim projects above the table. The distance of its withdrawal downwards is just sufficient to clear the mould. The moulding boxes H are specially designed for the work, being made to have the minimum spaces for sand ramming, and having both concentric and radial stays, so that liftering in the top is not required.

Another machine, built for the same general purpose, but differently actuated, is shown in Fig. 2, being one by the London Emery Works Company. Substantially the same mechanism is included, but the handwheel and the gears that drive to the central operating screw are differently disposed. The gears and screw are protected from sand by the hollow cylindrical base on which the table is carried.

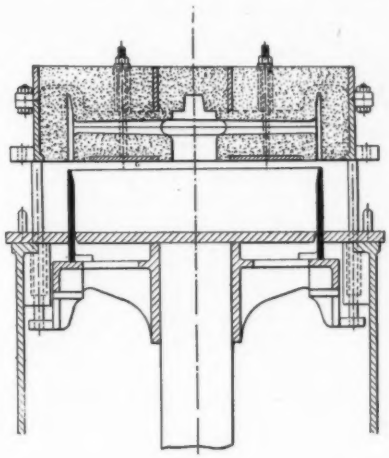


FIG. 6.

The pattern rim is bolted to the cross-arm table A, which is moved up or down by the central screw operated from the handwheel through bevel gears. The stripping plate rings B, C, inner and outer, are changed for each pulley of a different size. The inner plate B carries the half-arm thickness. After a half-mould has been rammed and pulled down, the cross portion A, moved round by a lever, not shown, is brought under the lifting rods *a*, *a*, through which on reversing the handwheel the moulding box is lifted on the rods clear of the arms, delivering from them. The lift need not be much higher if the boss is left loose to come away in the mould.

The drawings Figs. 3 to 7 illustrate the method of making *double-armed* pulleys on the machine. The pattern rim A, Fig. 3, is raised to a height from the table equal to half the intended width of the casting. The sand which occupies the space between the arms has to be carried on grids B which fit with a marginal space between their edges and the edges of the arms, so that they can be extracted from the casting. These can be single and separate, each with its own bolt long enough to come up beyond the top edges of the flasks as shown. Or they may be connected with arched rods, cast in, reaching over the arms,

and only three bolts then need be used. The grids are laid upon the inner stripping plate C, and sand is rammed over them occupying the interior of the pulley rim up as high as the central plane *a* of the arms, as illustrated, where a joint face is sleeked. The arms may be the ordinary divided-pattern arms or solid ones. It is well to strickle down from the top edge of the pulley rim to the central plane of the arms, and then bed them in, finishing the joint face afterwards. Parting sand is strewn on this.

In the next stage, Fig. 4, the half moulding box is laid on the table and the portion of the pulley that comes above the arms is rammed, and also the outside of the pulley down to the face of the table. The bolts which come up through the box are enclosed in tubes *b*, rammed in the sand.

The rim pattern, Fig. 5, is next withdrawn downwards. The moulding box is pushed off by the pins *c*, *c*, leaving the pulley boss and arms exposed, which are now removed. The mould is cleaned and blackened, and the box returned into its place, and secured to the inner core by screwing up the bolts from the grids (Fig. 6).

The ramming of the second box is just a repetition of that of the first, the two being exactly alike. The setting of the central core completes the mould, which is now closed (Fig. 7), and the pouring basin made over the boss.

The telescopic design of machine marks a substantial advance on the loose-pulley type, but it is not one which is suitable for the general shop. Dia-

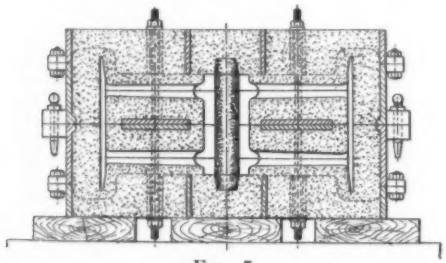


FIG. 7.

meters and thicknesses are rigidly fixed in the grouping of rings in any one machine. The numbers provided will range from ten to nineteen in machines of different sizes. The methods of moulding are the same as those already described, the pattern rings and the details of their operation alone differing.

In the machine shown in Fig. 8, the pulley pattern rings are seen grouped at A, and lying concentrically on four brackets B, which project from the main casing C of the body. Either one is put into operation by inserting dovetails cut on the brackets D into corresponding dovetailed grooves cut in the lower edges of the rings A. By means of a handwheel E, and a scale at *a*, any one ring is selected as desired for moulding. The handwheel E moves the four brackets D, which carry the engaging dovetails inwards or outwards, through the medium of screwed spindles F, which turn in bronze nuts G in the lower ends of the brackets D, the bosses of which encircle guides H, in a cross J. The four brackets are moved in unison by the nest of gears K, from the handwheel E.

The cross J which carries the guides is itself moved upwards or downwards for the vertical adjustment of the pulley rings by the handwheel L through worm gears to the pinion M, and the rack N. The upper figure, it must be noted, is drawn to combine two sections at right-angles through the shafts of wheels L, and O—compare with the plan view. The height to which a ring is set is shown by a scale. No direct measurement is therefore employed.

When a ring equal in depth to half the casting required has been moulded, it is withdrawn downwards through the table by the handwheel L, and the gears which it actuates. The box is then lifted off by the handwheel O. The method adopted is unusual. A ring P on the interior of the casing carries four inclined planes Q, which ring is rotated by the hand-

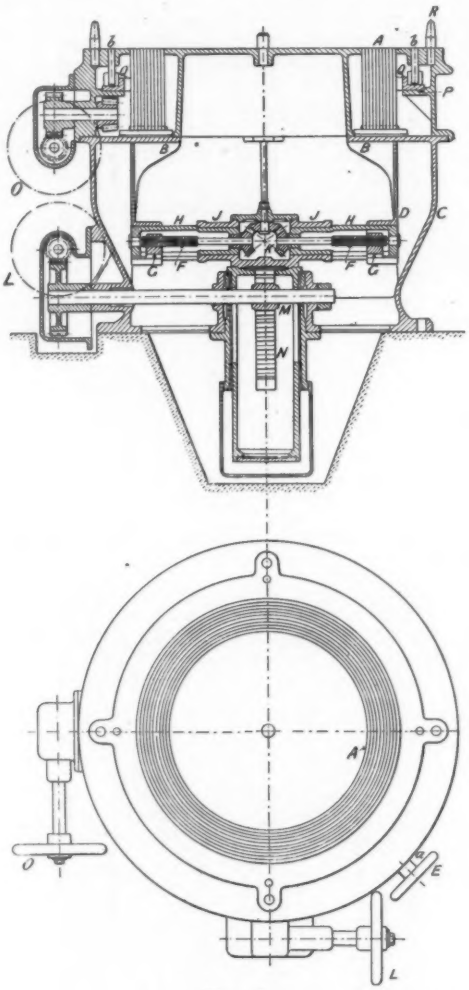


FIG. 8.

wheel O through the worm and bevel gears seen. Each of the inclined planes receives a roller, or alternatively a sliding piece, which is pressed against the planes Q by a spiral spring. Each sliding piece carries a pin *b* on its upper end, which pin is level with the table when the sliding pieces are in their lowest position. When the ring is rotated the box is lifted by the slides high enough to clear the arms, and to detach the box lugs from the pins R. The moulding of the two half-boxes is identical.

The machine shown in Fig. 9 affords an illustration of like results being achieved by means of a

different design. To select one of the rings, A, required, the handwheel B is turned, which through mitre gears C and D actuates a worm, *a*, and wheel. The latter rotates a sleeve on which are four lugs *b*. These communicate motion to four levers *c*, that are coupled by rods, and which levers therefore move the sleeves *d* in unison over the arms of a cross *e*. The blades *f* which are attached to the sleeves, moving inwards or outwards, select the ring to be moulded, and moving it up or down, serve for setting the proper height for moulding and withdrawal. Turning the handwheel B effects the first, turning the handwheel E the second, this being accomplished through worm gear to a rack in the central spindle, to which spindle the cross *e* is fastened.

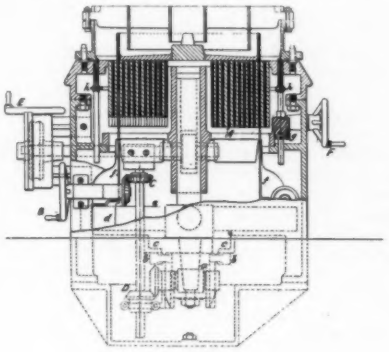


FIG. 9.

The mould is lifted off by turning the handwheel F. In later machines the inclined planes are embodied. But the illustration shows an earlier alternative method, that of a spiral gear *g* on one of the lifting pins screwed into the table of the machine. Its motion is communicated to the other pins by a horizontal pitch chain *h*, *h*.

Causes of Shrinkage Cracks in Steel Castings.*

BY WILLIAM R. BOSSINGER.

Shrinkage cracks in steel castings constitute a common defect of steel foundry operations. The cause of shrinkage cracks is the same for all castings, but their locations are never identical, owing to the varying forms of different sections. It is not unusual to make castings from one pattern for a period of several months without being troubled by this defect, yet suddenly all of the castings from one heat will develop these cracks. To reduce these defects or to eliminate them entirely, every effort should be made to prevent setting up solid walls that will cause the metal either to stretch or crack when the force of contraction is brought to bear on the walls of the moulds.

Numerous appliances, devices, etc., are resorted to to overcome this defect, including the use of brackets, chillers, tie bars, the use of sawdust or cinders in the cores, maintaining the metal at a minimum temperature when pouring and keeping it as low in sulphur as possible, as too high a percentage of the latter element is one of the common causes leading to shrinkage cracks. Long castings with attached ribs, flanges, or lugs will crack if the sulphur is not well under 0.05 per cent. in basic steel, regardless of the fact that other properties and conditions may be favourable to the elimination of this defect.

Each casting presents a different problem, as the thickness of metal and the lack of uniformity in section will change the location of cracks in one casting as compared with another of entirely different form. It is not unusual to stop cracking in one part of a casting, only to have this defect develop in another part of the same piece. This, however, should not prove discouraging, as it indicates that proper methods are being taken to prevent these defects. The law of the segregation of metals should be recognised as being closely allied to the causes underlying the formation of shrinkage cracks. Segregation will cause the formation of shrinkage cracks on the outside surface of many castings.

Use of Chillers.

The free use of "chills" or chillers is recommended, as they will reduce this defect by controlling the cooling to a greater extent than the use of brackets. Unless efforts are made to prevent the employment of chillers that are too large or heavy, or which extend over on to the junction of heavy and light sections, the chills will increase the tendency to crack. If the chiller is too large, it will cause shrinkage cracks at the point of the chilled face. This is caused by the too rapid contraction of the casting directly underneath the face of the chiller. When the chiller is of the proper thickness, it causes the heavy part of the casting to pass through the first stage of contraction, imparting to the metal sufficient strength to meet the stresses caused by passing through the first cooling stage. Stresses in the chilled parts of steel castings are eliminated when the proper chillers are employed. The latter will absorb heat from the casting until they reach a temperature of 1,400 deg. Fahr. and on cooling with the casting all stresses should be relieved, as the casting strains are released by what practically constitutes annealing at this temperature. The use of chillers is resorted to for the purpose of reducing the size of feeders on many castings; they are inserted in the moulds over lugs and flanges that have light, thin sections on top. A chiller should be of sufficient size to set the heavy section of metal before the metal in the lighter section has left its fluid state. In this way fluid steel will be carried to the chilled part and other fluid steel will be drawn from the feeder to replace metal taken from the lighter section. Another reason why the chiller is to be favoured in place of the use of brackets is that the chiller will fall out of the mould when the casting is shaken out, whereas the brackets have to be chipped off.

Gating.

Improper gating also is frequently the cause of shrinkage cracks, forming hot spots in line with the flow of metal. If a flat casting is gated in the centre and the metal is forced in one direction, causing the sand to absorb and retain heat in this section of the mould, thereby causing a hot spot in the casting, resulting in a shrinkage crack, it can be attributed to the remainder of the casting cooling and contracting in advance of the centre of the hot section. If, for example, an I-beam section be gated in the centre of the web, the casting will be liable to crack, as the flanges will resist contraction and the centre will be weakened by the higher temperature of the metal due to the method of gating in the web and this part of the section would not have sufficient strength to withstand contraction and the crushing of the sand walls on the flanges.

* From Paper presented before the Annual Meeting of the American Foundrymen's Association.

Reclaiming Moulding Sand.

Before the American Foundrymen's Association, last month, Messrs. W. M. Saunders and H. B. Hanley contributed a Paper in which the reclamation of moulding sand by restoring the bond by means of clay was discussed. In the course of their remarks the authors said:—

What takes place when moulding sand is heated is not definitely known, but one result is the loss of bonding power. Moulding sand heated a little above the temperature of boiling water loses very little bonding power. As the temperature to which the sand is exposed is increased a greater loss takes place until at the temperature of red-hot metal the bond is destroyed and the sand no longer possesses the property of moulding sand. In an experiment, sand having a bond expressed by the number 480 was heated for the same length of time at different temperatures. The result of the heating was to reduce the bonding power as follows:—

Heated at Degrees Cent.	Bonding Power, Number.
100	480
300	380
500	260
700	260
900	160
1,000	120

Heating for a longer period at 1,000 deg. C. caused the complete destruction of the bond. All moulding sand in contact with very hot metal loses bond, and the longer the time required for cooling the casting the greater the penetration of heat into the sand mould, and consequent larger loss of bond. For this reason it is desirable to remove the castings from the sand as soon as all danger of too sudden cooling has passed.

The bonding property of moulding sand is due to the amount and quality of the clay contained therein. In determining the bond of moulding sand advantage is taken of the fact that clay has the property of adsorbing various dyes, the amount adsorbed depending upon the quality or plasticity of the clay. Hence, in moulding sand, the greater the plasticity and bonding power of the clay present the larger the amount of dye adsorbed.

There are three important tests to be used in studying the value of moulding sands:—(1) Rational analysis; (2) mechanical analysis; and (3) bond test, as indicated by the dye adsorbed.

The rational analysis consists of treating the moulding sand in a manner to show the amount of quartz, feldspar, and clay substance contained. The mechanical analysis consists in separating the moulding sand into various sizes, held on sieves of increasing fineness, and is usually expressed in percentage held on the different mesh sieves. The bond test consists of treating the properly-prepared moulding sand with a dye dissolved in water, and the result expressed as milligrams of dye adsorbed by 100 grammes of the sand.

Mesh.	Percentage.
20	0 09
40	1.69
60	11.47
80	13.39
100	7.08
150	22.84
200	9.14
200+	17.32
Clay sub.	16.92
Bond test 500.	

For the purpose of restoring bond to moulding sand by the means of clay, we have been carrying on experiments for about three years. The experiments were made in a large foundry employing moulding machines making pipe fittings. The sand had the mechanical analysis and bond test shown in the above table.

The foundry was constructed after the two-storey style, the castings being shaken-out on to a grating, through which the moulding sand passed to the floor below to be mixed with new sand, tempered, and returned by means of conveyors to the moulding machines. The castings, with sprues and adhering sand, were picked up from the grating and dropped through a shute to the floor below. Considerable adhering sand was rubbed off the castings in passing them through the shutes, and accumulated on the floor at the bottom of the pile of castings. This burned and waste sand having a bond of less than 100 was reclaimed and added as new sand to the moulding sand being used. To reclaim this burned and waste sand it was first passed through a sieve to remove pieces of iron. It was next mixed with New Jersey fireclay having a bond of about 2,500, in the proportion of three parts of burned sand to one part of clay. This 25 per cent. clay mixture was then passed through a grinder, not for the purpose of making it finer, but to thoroughly mix the clay and sand by rubbing the particles together, and thus bring them into contact. By means of this it was believed the clay would cover and adhere to each grain of sand, replacing the bond destroyed in the original moulding sand. A new moulding sand was thus made having a bond of about 600 to be used in place of natural moulding sand. No other than this reclaimed sand was used by a number of moulding machines for several months.

Mechanical analyses made upon samples taken from the sand used on a moulding machine making 2-in. elbows at the beginning of the experiment and at the end of one month, three months and six months after, gave the following texture and bond:—

Mesh.	Beginning.	One month.	Three months.	Six months.
	Per cent.	Per cent.	Per cent.	Per cent.
20	1.80	2.08	2.72	2.22
40	5.78	4.60	7.20	6.50
60	11.40	10.80	11.32	11.37
80	11.44	12.32	11.50	10.64
100	6.04	5.88	6.62	5.90
150	21.33	23.16	20.88	21.20
200	9.77	9.06	8.44	9.23
200+	19.16	18.52	17.40	17.40
Clay substance ..	13.28	13.58	13.92	15.54
Bond test	304	336	344	312

It was found that the quality of the clay used for bonding should be suitable for mixing well with the waste sand, have high plasticity as indicated by the bond test, and be as highly refractory as possible. Later experiments showed the ground New Jersey fireclay possessed properties which made it possible to be mixed as a bonding clay with the waste sand by means of shovel and riddle, the grinder being unnecessary.

No attempt was made to clean the burned or waste sand by removing the finer portions, as the coarser bank sand carried into the moulding sand by cores helped to keep in balance the fine clay material.

The Use of Jolt-Ramming Machines.

By "Jay Bee".

Undoubtedly the jolt-rammer moulding machine is coming into its own in this country amongst the younger and more modern school of foundrymen. This useful tool has not in the past received the recognition it deserves, and we are a long way behind the United States in jolt-ramming practice. For small work we have a few good machines made in this country by British firms. The class of work done on these, however, is well catered for by other machines of the hand-rammed type, and there is a wider field for a machine doing jobbing work of a heavier sort, such as wall boxes, tank plates, flywheels, hangers, columns, locomotive cylinders, etc. Anything that has a straight draw can be successfully rammed on a jolt rammer. Brackets, bosses or projections on the sides of a pattern are not suitable for jolting, but these can be printed up and cored out if the pattern is suitable otherwise.

The action of jolt-ramming is simply that the weight of sand on the top rams the sand underneath, and the more sand there is on top, of course, the harder it will get below, according to the number of blows given. When a pattern has projections on the sides and jolting commences, the sand slides down the sides and away from the undersides of the bosses or flanges, and each successive jolt simply drops the sand further away.

Some of the American machines are designed to handle moulds weighing up to 10 tons. In the shop where the writer is employed there is one installed which takes a box 6 ft. by 4 ft. by 5 ft. deep, and which with pattern and sand complete, weighs about 5 tons. This is rammed in about 1¼ minutes, and the moulders are loth to ram anything by hand which can be jolted. The filling in of sand is done by hand, but this can be done mostly by labourers, and effects a considerable saving of wages. The initial cost of these machines is heavy, but the running expenses are light, and they do not need a lot of attention. Some of the more pretentious machines which turn over the mould and draw the pattern do require the fitter very often, but no doubt these faults will be dispelled in the early future. The chief advantages of the jolt-rammer lie in its speed and evenness of ramming.

Moulds made on a jolter do not need as much venting as those rammed by hand, on account of the porosity of the sand which allows free exit to the gases. When a mould is hand-rammed, each course consists of a layer of sand which is harder next the top than the bottom side where the rammer has not penetrated to, and consequently the gases have to have an exit provided for them through the hard places. The writer knows of certain jobs which had to be needle-wired and sprigged to prevent scabs when hand-rammed, but which are now jolted and not even vented on the drag before turning over. The amount of sprigging has been reduced 75 per cent., and better castings are being got, free from scabs and swellings.

The disadvantages of the jolter can be largely overcome by good management—central position of machine and a big sand heap where the labourers do the filling in, good crane service to and from the jolter, and a good supply of turnover boards, clamps and wedges. Drags do not present any difficulty in ramming, but top parts are not so easy to get. The jolt which rams around the pattern and down into the box also imparts a shock to the stays or bars of the flask, and loosens the sand from off them. The same thing applies to gaggers when hung on the bars, but is not so noticeable when they are not hanging, as they then sink with the body of sand. Flat tops need to be clamped to the table or board, and the bars have to be well tapered and come within about 1½ in. of the face. Also it is advisable to give them an extra good dose of the flat rammer on the top side, and they cannot do without fingering or filling up on the face side where the bars come, owing to the sand not sinking underneath them. In fact, there is not much profit in ramming flat tops, as the moulder can generally do this as quickly on his own ground as he would if he had to wait for the crane to transport his box, and when jolted do the extra finishing at the soft places under the bars. A certain amount of discrimination is necessary in these matters, because some jobs which seem at first glance good subjects for jolting do not on close examination recommend themselves so much when one considers the plant he may have to provide, and perhaps a patternmaker's time to make alterations to a pattern which may have only one off. For plain stuff with large orders off there can be no doubt the jolt rammer is a big money-saver, and the sooner British foundrymen awake to the fact the better.

Casting Blast-Furnace Bells.

By "Erimus."

Bells for the tops of blast furnaces may be either of cast iron or composite, *i.e.*, of a cast-iron top and ring with mild-steel plating, the joints being made with flats and tees or angles. Some blast-furnace people are now having all-steel bells built up of mild-steel segments of two or three thicknesses, with cast-steel tops and rings; and these, although costly to make, last much longer than ordinary cast-iron or composite bells.

The tackle, including bricks, to make a solid cast-iron bell 11 or 12 ft. diameter by 4 ft. 6 in. deep will weigh anything between 10 and 20 tons. Some founders prefer to have a cast-iron casing for moulding the bells in, and where repetition orders are assured, no doubt this would be the cheaper mode of making. Unfortunately for the founder, blast-furnace top castings differ considerably in design, and bells from 9 ft. to 12 ft. diameter are used—hence the necessity of a varying method of making. Where storage space for tackle is scarce the most suitable plan is to make the bell in a brick and iron mould, as when not in use the loam-plates, which are flat and have very short prods on, are easily nested together.

The following notes describe the *modus operandi* to make a solid cast-iron bell 11 ft. diameter. Such bells are generally moulded inverted. A bottom plate about 15 ft. diameter with lifting lugs is made first; this need not be prodded. A coating of loam is spreaded on it, and building of the mould with bricks commences. The section of the finished bottom mould is seen in Fig. 1 (right-hand half). To save bricks and coke for drying, the mould need not be built up solid. Stout pillars of bricks in the lower part of the mould are quite sufficient to carry the top part of the outer mould.

There are two ways of making the core. One is by "thicknessing" the mould, *i.e.*, sweeping a temporary layer of loam the thickness of the casting in the mould (see left-hand half of Fig. 1), and then building the core up inside, which saves the trouble and risk of turning the core over, but renders more difficult the scrubbing and blacking when lifted out, as the man has to work underneath to do the necessary

finishing of the core. The alternative is to sweep the core on a plate, as shown in Fig. 2, and turn it over when finished. In either case a prodded crown-plate is essential for the nose of the core, and as the brick-work is built up the moulder will require either one or two cast-iron rings to carry it. These rings, as well as the crown-plate, must have staples cast in for fixing with hook-bolts to the top plate. The core again need not (for economy in bricks and coke for drying) be built up solid; a hole can conveniently be

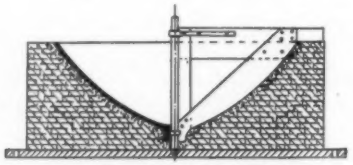


FIG. 1.—(LEFT HAND) TEMPORARY THICKNESS OF LOAM SWEPT IN READY FOR MAKING CORE. (RIGHT HAND) SWEEPING OUTER MOULD.

left in the middle to allow the mould to dry quicker when put in the stove. The gases generated during casting have a better chance of getting away when moulds are not built solid.

Care must be taken to bolt the top and bottom plates together. A few cramps of square iron also can be safely recommended to stop the plates from springing, and as a precaution a number of open-

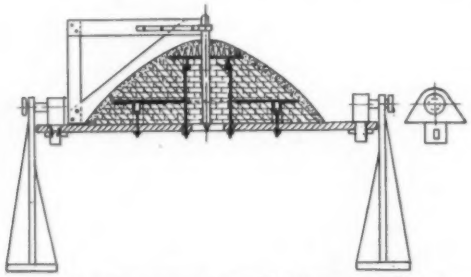


FIG. 2.—SWEEPING CORE SEPARATELY. LOOSE JOURNAL KEYED ON FOR TURNING CORE OVER ON STANDS.

sand plates all round the outer mould and held by chains ensure that the brickwork will not burst away with the tremendous pressure of the molten metal inside the mould when casting it.

When the two halves of the mould are made, if "thicknessing" has been adopted, the top is lifted out and blacked ready for casting. Provided it has been well stoved and all moisture driven out, a few

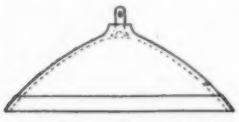


FIG. 3.—BLAST FURNACE BELL.

box-fires underneath with sheet-iron plates surrounding the mould to keep heat in are all that is necessary to dry the blacking. The thickness of loam may then be removed and bottom mould scrubbed, blacked and dried ready for assembling for casting.

If it is preferred to sweep the core separately, care must be taken to see that the crown plate and rings are all well bolted up to the top plate before it is turned over. This can be done on a soft heap of loam, or, better still, on a couple of high stands made for the purpose.

To counteract contraction strains it is advisable that a quantity of loam-bricks be built into the core as it is made up. Care must also be taken to see that the crown-plate and lifting plates are not made too big in diameter to stop the natural contraction of the casting. Fig. 3 shows the bell when cast. It is thickened up at the bottom for machining, as gas-tight joints are generally wanted.

British Foundrymen's Association.

Branch Programmes.

London Branch.—The meetings of this Branch will be held at Cannon Street Hotel, Cannon Street, E.C., under the chairmanship of Mr. A. Willis (Branch President), at 8 p.m., on the following Fridays:—

October 22, 1915.—"Practical Science and Physical Laws in Foundry Work," by T. W. Aitken (Luton).

November 19.—"Some Notes on a Tour of Continental Foundries," by H. G. Barrett (Erith).

December 17.—"Copper-Aluminium Alloys," by Professor C. A. Edwards (Manchester University).

January 14, 1916.—"Brass Foundry Practice," by F. C. Barker (London).

February 18.—"Some Scientific Considerations in Steel Founding," by W. A. Naish, A.R.S.M., A.I.M.M. (London).

March 17.—Lecture to be arranged.

April 14.—Lecture to be arranged.

The officers for the session are:—President, Mr. A. Willis; Vice-Presidents, Messrs. A. R. Bartlett and T. W. Aitken; Secretary, Mr. Alexander Hayes, 165, Strand, W.C.

Birmingham Branch.—The meetings will be held under the chairmanship of Mr. D. Dalrymple (Branch President) at the Municipal Technical School, Suffolk Street, Birmingham, at 7 p.m., on the following Saturdays:—

October 23, 1915.—Presidential Address, "The Making and Using of Pattern Plates," illustrated with lantern slides, by D. Dalrymple.

November 27, 1915.—"Cast Malleable Iron and Cast Steel," by A. Harley (Coventry).

December 11, 1915.—Discussion, "Core-Binders, with Special Reference to Oil Compounds," introduced by J. G. Robinson (Halifax).

January 22, 1916.—"Chill Castings in Non-Ferrous Alloys," by F. Johnson, M.Sc., Metallurgical Department, Municipal Technical School, Suffolk Street, Birmingham.

February 26, 1916.—"Loam and Dry-Sand Moulding—a Comparison," with practical illustrations, by J. Shaw (Dudley).

March 11, 1916.—"Carbon and Iron," by Professor T. Turner, M.Sc., A.R.S.M., etc., Birmingham University.

March 25, 1916.—"Some Characteristics of Iron: Their Transmission to the Castings," by R. Buchanan, F.R.S.A. (Birmingham).

March 25, 1916.—Annual meeting, at 6.30 p.m.

In addition to Mr. Dalrymple, the other officers are:—Vice-Presidents, Mr. J. Shaw (Dudley) and Mr. J. J. Howell (Birmingham); Mr. C. Grindlay, 39, Copeley Hill, Erdington, Secretary.

The Renaissance of the Foundry.

At the opening meeting of the 1915-16 Session on September 24, of the London Branch of the British Foundrymen's Association, Mr. A. Willis, the newly-elected Branch-President, gave a brief address, in the course of which he said: The iron branch of the foundry trade is the branch of big things—big foundries, big cupolas, and big castings. We of the non-ferrous branch, dealing in the more valuable and expensive metals and alloys, have to be content with the smaller foundry, the crucible, and the light castings. The non-ferrous foundry, however, has no less interest, needs no less skill and technical knowledge, and provides quite as many problems for the earnest foundryman to solve. The problems of each branch are to a large extent the same, and the end in view is exactly the same, namely, the production of good castings.

Mr. A. Willis (*President of the London Branch of the British Foundrymen's Association*).

In looking back over the experiences of over 40 years' in the foundry trade, one is struck with the growing change of thought in recent years on the part of engineers, employers, chemists and metallurgists with regard to the foundry. The foundryman, once the Cinderella of the engineering trades, is now beginning to take his proper place, and it is becoming more and more realised that his part in production is quite as important and necessary in the processes of manufacture in our great metal and engineering industries as is the work of the engineer and the draughtsman. The practical foundryman is also now taking more part in the management of foundry affairs. In the past the foundry has been under the management of the engineer, the pattern-maker, the draughtsman, the chemist, or even in some cases the storekeeper—anyone, in fact, but the man of practical experience, the idea being that he was "only the man who made holes in the sand to pour the metal in."

We have heard a good deal lately about the low standard of the foundry worker, and more especially the young lads coming into the trade. I think I have here indicated one great reason for this, so far as it is true. In the same sense that it was said that every private in the French Army carried the Field-Marshal's baton in his knapsack, so in the foundry there should be the opportunity for the practical man to take the reins. Give better opportunity for advancement, improve the economic conditions of the foundryman, and an incentive will be given which has been very little in evidence in the long past. Then a better type and standard of worker will undoubtedly be drawn into foundry work.

Another great drawback to the foundry in the past has been the neglect of our trade requirements by the technical schools and the education authorities. I remember almost the beginning by Sir Quinten Hogg of the great Polytechnic movement, now taken up by the State and developed into a great scheme for Technical Schools for the whole country. The foundry trade, alas, was either forgotten or for some other reason left out of the curriculum of most of these schools, and thus again the foundryman has lacked the opportunities given so freely to other trades. The steps being taken by the B.F.A., in regard to the training of apprentices and the provision of technical classes, are a move in the right direction, and should have a great effect in the future on the improvement of the status of the foundryman.

The foundryman of the future must be both practical and theoretical; he must be his own chemist and metallurgist, have some share in pattern design, some voice in methods and machinery of production, and the selection of his metals and other materials. He has in the past had to bear the blame for all mistakes and failures in castings, whether due to faulty design, inferior metal or lack of proper tools and appliances. This has been largely due to the want of knowledge of foundry problems on the part of employers and managers.

Through the same reasons the foundry has been exploited by the metal merchant with inferior metals, and by the manufacturers and merchants of all kinds of foundry appliances, plant and fluxes, etc.—good, bad or indifferent, suitable or unsuitable for the class of work done. Nostrums of all kinds have thus been foisted upon the foundryman, who has been quite unable to give the results so glibly promised by the merchants, and so has been discredited in his efforts.

Foundry work has been to a large extent a groping in the dark, a dealing with the unknown, handling metals and materials of unknown composition, qualities and properties, a veritable struggle against the operations of natural laws imperfectly or not at all understood. The literature of the foundry in the way of data and text books has been very meagre, and mostly unreliable, and lacking in the practical details which the foundryman most wants to know. He has had, therefore, until very recent years, to carry on what are now known to be highly complicated, scientific operations without much guidance except that gained by his own personal experience by observations of actual results attained in practice; and when we consider, from the point of view of present-day knowledge, the intricacies of foundry problems, we can only wonder at the excellent results that have been attained in spite of all difficulties.

In thus making claims for the practical man, I do not in the least underrate the work done in recent years by the scientific man for the solution of foundry problems. Many great chemists and metallurgists have been and are doing valuable service to the foundry by the experimental and research work they are engaged in. Many institutions and scientific workers are making valuable enquiries into the properties of the various metals and alloys, and it seems likely that many of the problems of the foundry, known and solved in his own way by the practical man, will be explained from a scientific standpoint as the result of these researches. There is a vast field open for the chemist and the practical foundryman working in co-operation.

The alloying of the common and rare metals in many different proportions, and the study of the effect of small and minute quantities of metals one upon the other and in combinations form a wonderful experience; and I venture to say this subject holds possibilities in the future for the production of alloys with properties undreamed of at the present time

These possibilities may be realised when it is stated on the authority of Roberts Austen that the possible compounds or alloys with the thirty common metals reach a total of 1,013,985—a veritable fairyland of exploration and discovery for the earnest worker.

By the help of such researches and by the co-operation of the practical and theoretical sides of foundry knowledge, and by the better system of education for foundrymen which is now being urged by the B.F.A., the foundry is destined in the near future to take its full place on an equality with the other branches of the great engineering industry, as no less important than the drawing office, the machine shop and the pattern shop.

Mr. A. R. Bartlett (Vice-President) proposed a hearty vote of thanks to the President for his address.

Mr. J. Oswald (Past-President), in seconding, said that the non-ferrous side of the trade had a worthy representative in Mr. Willis, and with him as President of the Branch they would have a better chance of having their requirements brought to notice. The foundry, he agreed, had made very great strides in the last few years, and would undoubtedly soon take a more prominent place in engineering.

AN EXAMPLE OF WELFARE WORK IN THE FOUNDRY TRADE.—To see employés emerge from a steel foundry appearing as though they had done anything but a day's hard work amid heat and dust is not usual, says "The Iron Age," in describing a welfare building recently opened for the employés of the Reading Steel Casting Company, Reading, Pa., U.S.A. The building is located adjoining the plant of the Company, and is the headquarters of the Reading Steel Casting Relief Association. Several employés of the Company formed a relief association on August 10, 1910. Previous to this it had been the custom to take a collection for a fellow workman who was reduced in circumstances by accident or sickness or otherwise. The Association gained in favour and membership until to-day every employé of the 230 to 250 men belongs to it. Some time after the organisation of this Association headquarters were established in a small building on the Company's property. New headquarters were started last year by the Company, and the building was completed recently. The basement contains 290 lockers, five shower baths and 28 stationary washstands and toilets. These are used by nearly every employé morning and night. The baths have hot and cold water. An emergency hospital, equipped with a large medicine closet and first-aid appliances, is located to the right of the main entrance on the first floor. Temporary relief is administered here to extreme cases, while injuries of a less serious nature are also attended to. To the left of the entrance is an office for officers of the Association, as well as a store. Cigars, tobacco and candy are sold here, as well as workmen's gloves and other articles for the convenience of employés. A well-aired reading and writing room is also found on this floor and a billiard and pool room. A kitchen takes up the remainder of the space and is used to prepare luncheons. The second floor is completely absorbed by a large assembly room. The wood finishing of the interior is green, while the heating and lighting plant is complete and modern. Flower beds and shrubbery have been planted on the lawn around the building. A result of this undertaking by the Company is declared already to be a unifying of the whole organisation into a more co-operative group, as well as the promotion of greater sociability. The building is regarded and used as a home in the evening as well as in the day time. The presence or use of liquor is entirely prohibited.

Metallurgical Instruction at London Polytechnics.

SOUTH WESTERN POLYTECHNIC, CHELSEA.

As is fairly well known, the London Polytechnics are institutes which give courses of education in a variety of subjects both in the day and evening. These courses are in most cases of a senior type, and are intended for students over 17 years of age. In some institutes the work is carried to a very high standard, reaching to the research necessary for the degree of Doctor of Science. The fees are all very moderate. We have before us the syllabus of instruction given at the South-Western Polytechnic Institute, Manresa Road, Chelsea, S.W., which includes an admirable course in metallurgy. The Metallurgical Divison's equipment includes a furnace room containing wind and muffle furnaces suitable for metallurgical operations and dry assays, and rooms for weighing, conducting blowpipe work and wet assays. It has recently been fitted with modern appliances for special work, including a modern micrograph apparatus, photographic studio, dark room and accessories. Apparatus for calorimetry, resistance and thermo-couple pyrometers, fuel analysis and electro-metallurgical apparatus are also included.

The courses are suitable (1) for technical students requiring a knowledge of the properties of metals, ores and alloys; (2) for intending colonists and others who wish to acquire a knowledge of assaying, particularly of gold and silver; (3) for university students who intend to study for the B.Sc. degree in metallurgy. A special class on photo-micrography is held on Monday evenings during the third term from 7.30 to 10. The lecture courses cover the following ground:—

First Year Metallurgy (*Elementary Course*).—In this course of lectures the general principles of metallurgy and metallurgical operations are described and a limited number of metals and typical operations treated of:—Physical properties of metals and alloys; specific gravity, malleability, ductility, tenacity, fusibility, etc.; explanation of the terms and processes—ore, gangue, calcination, reduction, smelting, regulus, liquation, cupellation, etc.; slags and fluxes, refractory materials, crucibles, retorts and furnaces; coal, coke and other fuels; coke-ovens; gas producers; the metallurgy of iron and steel, gold, silver, lead, mercury, copper, zinc and tin.

Second Year Metallurgy (*Advanced Course*).—In addition to the matter of the previous course, the list of metals is extended and recent work in micrography and pyrometry described. Special attention is given to the subject of iron and steel:—Alloys; bearing metals; refractory materials and fuels, including liquid and gaseous fuel; metallurgy of iron, steel, gold, silver, lead, bismuth, cadmium, mercury, platinum, copper, zinc, tin, nickel, aluminium and antimony; utilisation of by-products; the micrographic structures of metals and alloys; calorimetry, pyrometry and melting-point curves; the electric furnace; electric smelting; electrolytic extraction of zinc, tin, nickel and aluminium; pyritic smelting; gas analysis.

Engineering Course.—This course is designed to meet the requirements of those interested in the properties and uses of the various metals used in engineering industries. A considerable portion of the time is devoted to the treatment of the different varieties of iron and steel used for industrial purposes. Attention is also given to the manufacture and treatment of alloys:—Refractory materials; moulding sand; solid, liquid and gaseous fuels;

calorific value; physical properties of metals; iron and steel manufacture; blast-furnace and foundry practice; Bessemer and open-hearth processes; tool-steels, chilled castings, tempering, hardening and annealing; manufacture and use of commercial alloys; pyrometry; gas analysis; furnace building; electric smelting; electric and oxy-acetylene welding; oil furnaces; water softening; testing of steels and alloys; die casting. PRACTICAL WORK.—Testing of fireclays and sands; simple metallurgical operations; calorific value and analysis of fuels; preparation and testing of alloys; forging and hardening of tool-steels; gas analysis; pyrometry; steel analysis; testing of oils.

Principles of Assaying.—A course of lectures on assaying is given during the session. The metallurgical laboratory is open for practical assaying and general analysis during the day, and students may either follow an approved course or suit their own individual requirements.

Lectures on Foundry Practice.

During the present session a course of lectures on foundry practice will be given by Mr. W. A. Naish, A.R.S.M., A.I.M.M., Member of the British Foundrymen's Association. The lectures will be arranged to suit the requirements of foundry foremen, under-managers, managers, and men interested in foundry work generally. Attendance at a course of this nature will be of benefit to those engaged in the foundry trade, as a knowledge of the fundamental principles of metallurgy will be obtained which underlie the processes of moulding, casting and annealing. The syllabus will include:—Chemical and physical laws appertaining to foundry work; commercial metals; effect of impurities; composition of iron; annealing, hardening and tempering; malleable cast iron; melting and casting; types of furnaces; oil and coke furnaces; tilting and pit furnaces; the character, composition and testing of moulding sands; artificial sands; conclusions to be drawn from recent literature on moulding sands; casting of brass; white metals and patent alloys; mechanical testing of metals and alloys; the proper use of analysis in the foundry; fuel, solid, liquid and gaseous; temperature measurements, types and uses of pyrometers; metallography as a practical aid to the foundry manager; composition and selection of refractory materials.

Course for Foundry Apprentices.

In connection with the movement started by the Apprentice Training Committee of the London Branch of the British Foundrymen's Association, a course of instruction suitable for foundry apprentices is being arranged. This course, owing to the present war condition, is at the moment in abeyance, but will be started at the earliest suitable opportunity.

There are prospects of most of the other institutions in the London area co-operating in the scheme put forward by the Foundrymen's Association and starting classes on foundry work, designed to meet the requirements of apprentices and others, in accordance with the recommendations made by the Association.

NORTHAMPTON POLYTECHNIC.

The Northampton Polytechnic Institute, Clerkenwell, is another well-known institution which offers instruction of use to the foundryman. In the courses of the Civil and Mechanical Engineering and Metal Trades Department are included classes in pattern-making and moulding. The pattern-making class is held in the carpenters' shop, which is well equipped for this work. The course of work is arranged to suit the individual needs of the students as much as possible, and each example is selected so as to exemplify some important point in pattern-making. The subjects dealt with comprise:—The position of mould joints; contraction of castings; amount of taper necessary; allowances for machining; loose parts for undercut moulds; cores, core-boxes and prints; the halving of patterns; use of ramming boards; the turning of patterns in halves; methods of arranging patterns which have to be moulded in three-part boxes; construction of patterns for striking up moulds in loam; use of skeleton patterns; lagging and building up in segments; patterns for gearing, with the method of striking out teeth; materials and tools used in pattern-making; numbering, registering, and storing of patterns, etc. Short explanatory lectures are given from time to time by the instructor, and are supplemented by one or two special lectures on patterns for repetition work.

In the class on practical moulding the instruction given is suitable to the requirements of the general engineering student and draughtsman who may have to deal with engineering design, in which it is of the highest importance that a knowledge of the principles of pattern-making and moulding should be acquired. The course is also useful to trade students in moulding who are just commencing practical work. It is unnecessary to give a definite syllabus, as the work is arranged to suit the requirements of individual students. Short explanatory lectures are given from time to time by the instructor.

In the Metallurgy Section classes are arranged for the instruction of engineers (mechanical and electrical), brassfounders and workers, electro-platers, plumbers and tinplate workers, and others.

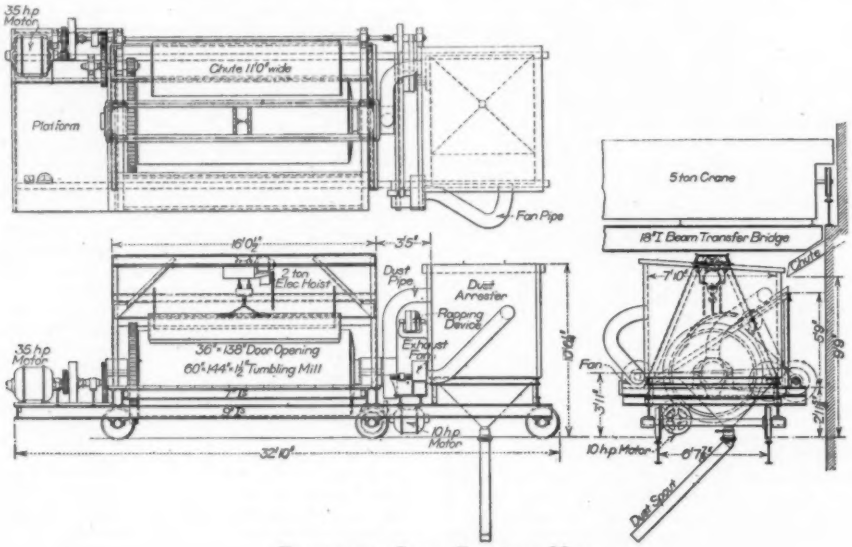
The elementary course covers the general principles of metallurgy, physical properties of the metals, colour, lustre, polishing; malleability, use of rolls; ductility, use of drawplate; hardness, use of sclerometer; specific gravity, methods of determination; tenacity, use of tensile testing machine; fusibility, elasticity, fracture, conductivity; effect of heat, working and impurities on the properties of metals and alloys; fuels; refractory materials; fluxes and pickles; the extraction from their ores of various metals and their subsequent manipulation in order to prepare them for use in engineering practice; alloys used in constructional work; various bronzes; bearing and antifriction bronzes; wrought, cast, and malleable cast iron; different brands of pig-iron; treatment in the foundry for special purposes; refining and puddling; forge and mill practice; machinery and furnaces employed; manufacture of steel; constructional steel castings; cast steel for tools; special alloys steels; hardening, tempering and other thermal processes; preparation of alloys of high electrical resistance.

The advanced course includes the chemistry of the metals as applied in the arts and manufactures, and is an advanced course of lectures and practical work, intended for those who have already a rudimentary knowledge of metallurgy and chemistry. Opportunities are afforded for students to carry out experimental work with electric furnaces of various types; also to obtain experience in spectrum analysis and spectrum and colour photography in the optical laboratories. A course of five special lectures on tool and spring steels will be given. The syllabus includes:—Alloys; the testing of metals; effect of heat treatment and of rolling, drawing and extension; thermal and microscopic examination of metals; metallurgical analysis; tool and spring steels, and assaying.

Travelling Mill for Cleaning Scrap.

A travelling tumbling mill for the cleaning of scrap, built by the W. W. Sly Mfg. Company, Cleveland, Ohio, for the St. Louis Screw Company, was described in a recent issue of "The Iron Age." The general design of the mill is illustrated in the accompanying drawings. The mill is mounted on motor-driven trucks which have a horizontal travel of 40 ft. per minute, thus providing for the spotting of the mill at any point along the piling bench for receiving or the delivery of scrap. The mill has capacity for cleaning 30 tons of scrap per hour, and is itself motor-driven by a 35-h.p. motor. It has a diameter of 5 ft. and is 12 ft. long, the shell being rolled from 1¼ in. flanged steel.

The heavy steel shell was rolled to shape with the horizontal joint opposite the door. The door was then sawed out after the shell was rolled up and riveted and the piece which was removed was riveted to a ⅜-in. cover which overlaps the opening and makes a tight joint. The door is fastened with special clamps. The mill heads to which the shell is attached with tap bolts are of cast iron and the trunnions are bolted to the heads inside the mill. The head covers are made of flanged steel and protect the entire area of the head, so that no cast iron is exposed to wear. Provision is also made for a pipe connection for the introduction of hot air through one of the trunnions for the purpose of drying wet scrap, which is then more easily cleaned. Through the opposite trunnion the exhaust to the dust arrester is taken off.



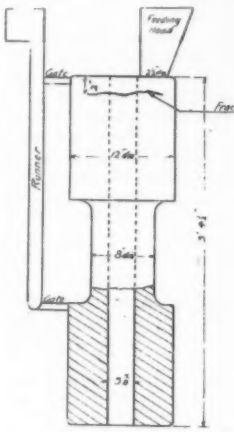
Travelling Scrap-Cleaning Mill.

The dust arrester is made of No. 16 gauge steel, riveted and bolted so as to make an air and water-tight compartment. The dust arrester shell is reinforced at the lower edges by steel angles, while the upright seams are of double-fold type, 3 in. wide, strongly bolted together and backed with tarred paper to prevent leakage. The vacuum in the dust collector, which sets up the circulation from the tumbling mill, is obtained by a fan connected through a clutch with the mill drive. All of the driving gears of the mill are of semi-steel, with chilled teeth. The trunnions are fitted with roller bearings.

Queries.

Cracking of Roll Castings.

I put the following difficulty before your readers and request their help:—We are making some rollers to the accompanying sketch in white hematite iron, and some of them fracture or rip about 2 in. from the top—some not much, but others go almost all the way round the casting. We have tried several ways of running and gating, and the best results come from the way here shown; still we get the fracture in some of them. In some cases we have fed them 10 to 15 minutes and then got the top box off, and found the fracture there. They are cast in dry-sand moulds made in facing sand, and well blacked with plumbago. If any reader has had any similar experience I should be grateful for any information or advice he could give. White hematite is not very well understood in many common-iron foundries.



"One in Trouble."

DUPLEX PROCESS IN CANADA.—Owing to the demand for open-hearth steel, the Algoma Steel Corporation has started the duplex process at its plant at Sault Ste. Marie, Ontario. The company is now considering the immediate installation of a 300-ton open-hearth furnace and 20-ton converters in order to produce more economically the larger requirements of open-hearth steel.

Trade Talk.

THE VONO COMPANY, of the Eagle Foundry, Dudley Port, are building large works near Dudley Port.

THE ALBION STEEL COMPANY, LIMITED, is being wound up voluntary, with Mr. Llewellyn Davies as liquidator.

BERGTHEIL & YOUNG, LIMITED, will in future trade as Berkeley & Young, Limited, the company being an entirely British one.

JOHN PHILLIPS (BRASS FOUNDRY AND LAMP COMPANY), LIMITED, have opened premises at 153, Farringdon Road, London, E.C.

THE BELGIAN COMMISSION OF MILITARY INVENTIONS has transferred its London office from City Road to India House, Kingsway, W.C.

MR. C. L. FAULKNER, 5, Laurence Pountney Hill, London, E.C., has been appointed British agent for the American Steel Foundries, of Chicago, U.S.A.

THE ACETYLENE WELDING AND LIGHTING COMPANY, of Nottingham, have transferred their works from Haslam Street, Castle Boulevard, to 52a, Grey Friar Gate.

AN explosion of no great magnitude occurred on September 24 at the Savile Street Works of Thomas Firth & Sons, Limited, Sheffield, some men being injured.

MESSRS. JAMES GORDON & COMPANY, engineers and contractors, have removed from 81 and 83, Knightrider Street, London, E.C., to Canada House, Kingsway, London, W.C.

THE receiver appointed in connection with the affairs of Chapman, Leonard & Company, Limited, London, S.E., is Mr. L. Chapman, Munton Road, New Kent Road, S.E.

MR. H. RICHARDSON, ironfounder, of 156, Denton Road, Hooley Hill, carrying on business at the Barn Meadow Ironworks, Ashton Street, Dukinfield, has been adiudged bankrupt.

THE ELOESSER STEEL DRIVING BELT, LIMITED, is being wound up voluntarily, with Messrs. F. J. Laverack, of London, and B. D. Potter, of Manchester, as liquidators.

THE ferro-alloy manufacturing works at Newton, Manchester, of the Continuous Reaction Company, Limited, are now in full operation, and the first deliveries have been made.

THE IRONITE COMPANY, LIMITED, 1, Victoria Street, London, S.W., inform us that owing to the rapid extension of their business they are removing to 11, Old Queen Street, Westminster, S.W.

THE public examination of Mr. H. Richardson, ironfounder, Barn Meadow Ironworks, Ashton Street, Dukinfield, Chester, will take place at the Town Hall, Ashton-under-Lyne, on October 8.

THE first meeting of the creditors and contributories of the Lancashire Brassfounders, Limited, River Street, Blackburn, will be held at the County Court Offices, Victoria Street, Blackburn, on October 6.

THE shareholders of the Western Engineering Company, Limited (in voluntary liquidation), will meet at 28, Baldwin Street, Bristol, on Tuesday, October 26, for the purpose of considering the liquidator's report.

THE shareholders of the New Chinese Antimony Company, Limited, have decided that the company be wound up voluntarily. Mr. C. Gitlan, of Milburn House, Newcastle-upon-Tyne, has been appointed liquidator.

THE partnership heretofore subsisting between Messrs. F. Lonsdale and W. H. Pickles, carrying on business as tool makers, at Alice Street, Keighley, under the style of Croft and Naylor's Successors, has been dissolved.

MR. F. HESKETH, iron founder, trading in co-partnership with M. E. Shaw as G. & A. Menzies, at 345, Chester Road, Manchester, will apply for his discharge from bankruptcy at the Court House, Manchester, on October 8.

THE shareholders of the Viaduct Foundry and Engineering Company, Limited, will meet at 4, Mount Stuart Square, Cardiff, on October 25, for the purpose of considering the liquidator's report of the winding-up of the company.

MR. T. SAMSON, previously associated with Böving & Company, Limited, hydraulic engineers, Union Court, Old Broad Street, London, E.C., has established himself in business in Stockholm, Sweden, as an engineer.

THE business of Messrs. J. & R. Hogarth, Kelso, engineers and millwrights, has been transferred to Messrs. Geo. Clow, Jas. Fairgrieve and Andrew Walker, and will be conducted by them as J. & R. Hogarth & Company.

THE firm of Barclay, Ross & Tough, millwrights, engineers, etc., Aberdeen, has been dissolved by the retirement of Mr. R. Tough. The business will be carried on by the remaining partners, Mr. R. R. Ross and Mr. T. Hutchison.

THE shareholders of the Preston Engineering Company, Limited, have decided to wind up the company voluntarily, for which purpose Mr. F. J. Markie, 83, Alberta Road, Bush Hill Park, Enfield, has been appointed liquidator.

THE partnership heretofore subsisting between Messrs. J. B. Guy and W. H. T. Hunter, carrying on business as engineers and ironfounders, at 21, Tempest Hey and Fontenoy Street, Liverpool, under the style of Guy & Hunter, has been dissolved.

MESSRS. J. BURGESS and R. BURGESS, carrying on business as engineers and shipsmiths, at Cleveland Street, Birkenhead, under the style of J. & R. Burgess, have dissolved partnership. The business will be carried on in future by Mr. Robert Burgess.

THE business of C. W. Robinson & Company, Limited, Forth Bridge Steel Works, Polmont Station, R.S.O., Stirlingshire, is being offered for sale by private treaty. The works are equipped with a 5½-ton Siemens' open-hearth furnace and 12 crucible pot holes.

HEENAN & FROUDE, LIMITED, and H. N. LEASK, have made application for the restoration of the patent granted to H. N. Leask for an invention, entitled "Improvements in Charging Doors for Furnaces," numbered 16,237 of 1910, and the patent of addition No. 29,638 of 1910.

Two hematite furnaces have been put into blast in the Cleveland district, one at the Thornaby Iron Works and one at the Normanby Iron Works. There are now 68 furnaces at work in the district, 30 of which are making ordinary Cleveland iron, 28 are on hematite and 10 on other descriptions.

IN consequence of the war, the erection of steel works by the Appleby Iron Company, Limited, has been postponed, but the work necessary to improve and extend the blast-furnace plant is well forward and in part completed. Meanwhile there has been a satisfactory increase in the production of pig-iron.

MESSRS. J. S. CRITCHLEY, J. W. H. EVANS, and S. E. BARLOW, carrying on business as engineers and agents, at Carlton House, Regent Street, London, S.W., under the style of Critchley, Evans & Company, have dissolved partnership. Mr. J. W. H. Evans will continue the business under the style of John W. H. Evans & Company.

THE first meeting of the creditors of M. E. Aspinall, trading as Joseph Aspinall & Company, engineer and iron founder at Bella Street, Daubhill, Bolton, will be held on October 6 at the Official Receiver's office, 19, Exchange Street, Bolton. The public examination will take place on November 3 at the Court House, Mawdsley Street, Bolton.

THE partnership heretofore subsisting between Messrs. H. Rix, W. Moore, W. Stoddart, and J. D. Paton, carrying on business as foundry specialists, at 333, Stretford Road, Manchester, under the style of Rix, Moore, Stoddart & Company, has been dissolved. Messrs. Rix, Stoddart & Paton will continue the business as Rix, Stoddart & Company.

The average price of Scotch pig-iron warrants during August, as ascertained by Messrs. Wm. Jacks & Company, was 71s. 6½d., which compares with 73s. 0½d. in July, 72s. 4½d. in June, 70s. 11¼d. in May, 72s. 8¾d. in April, 67s. 0¾d. in March, 62s. 6d. in February, and 62s. in January. The average price for August, 1914, was 58s. 3¾d.

The Minister of Munitions has made an Order under Section 4 of the Munitions of War Act declaring 180 additional establishments as controlled establishments under the Act, as from September 6. A total of 715 establishments have now been declared as controlled under the Act from the date of the first Order, July 12 to September 6 inclusive.

The works of Burys & Company, Limited, steel manufacturers, of Penistone Road, Sheffield, have now been wholly taken over by the firm of Samuel Osborn & Company, Limited. The new proprietors have decided that for the present the works will continue as Burys & Company, and the business will be carried on as usual.

Messrs. Wm. Jacks & Company, of Glasgow, have ascertained that the average price of Middlesbrough pig-iron warrants during August was 65s. 7d., as against 67s. 0½d. for July, 66s. 7½d. for June, 64s. 9d. for May, 66s. 7d. for April, 61s. 8¾d. for March, 56s. 5½d. for February, and 56s. 2d. for January. In the corresponding month of last year the average price was 52s. 4¾d.

One of the furnaces at Cleator Moor, belonging to the Whitehaven Hematite Iron and Steel Company, Limited, was damped down on September 24. There is now only one furnace blowing at these works. The same system, it is stated, will be applied during the temporary stoppage of this furnace, as formerly, the men dividing the shifts at the remaining furnace. The stoppage is not expected to be of long duration.

A meeting of creditors was recently held of Mr. Richard Thomas, The Foundry, Llanrwst, who came up for his public examination. The gross liabilities amounted to £1.750 12s. 4d., the amount expected to rank being £615 14s. 7d., the estimated assets being £160 10s., leaving a deficiency of £455 4s. 7d. The debtor attributed his failure to bad trade and liability for debts contracted by his deceased brother. The examination was closed.

A letter from the Midland Metal Dealers' Association on the subject of the sale of metals was considered at a meeting of the Newport Chamber of Commerce on September 24. The communication suggested an alteration of the law to abolish the weight limit, and thus enable dealers to purchase smaller quantities of metals than at present allowed. After due discussion, it was decided not to support the Midland motion, the Chamber preferring the Act to be strengthened.

A Special Munitions Tribunal sat at the Court House, Sheffield, on September 11, to inquire into a complaint against Charles Horton & Sons, Limited, brassfounders, 43, Union Lane, Sheffield, that they had given employment to a man who had not obtained a leaving certificate from his previous employers. The complaint was made by Benton Brothers, Limited, brassfounders, Rodley Lane Foundry. Sir Alfred Hopkinson, K.C., was chairman, and sitting with him as assessors were Mr. J. M. Gimson, employers' panel, and Mr. A. Shaw, workmen's panel. Defendants were fined £5, and ordered to pay £2 2s. towards the cost of the case.

A second statement of accounts has been issued by the liquidator of the Consolidated Diesel Engine Manufacturers, Limited, the result showing that there is now a probability of some small return being eventually made to the shareholders. On the other hand, the collection of book debts has proceeded very slowly, only £9,600 having been obtained out of a total of £26,000 classed in the original statement as good. The chief remaining asset is the half interest in Carels Frères. We understand that all creditors whose proofs have been admitted have received a dividend of 20s. in the £, and that a balance of rather more than £40,000 is left in the liquidator's hands.

Application was made to the Board of Trade on behalf of all the railway companies in the United Kingdom to amend the classification of merchandise traffic and schedules of maximum rates and charges fixed in pursuance of the Railway and Canal Traffic Act, 1888, by adding to the classification the following articles, viz.:—Molybdenite (molybdenum sulphide ore), nickelware (e.o.h.p.), and molybdenum metal powder. The Board of Trade heard the parties in support of the application, and there was no opposition, with the result that molybdenite (molybdenum sulphide ore) and nickelware (e.o.h.p.) have been added to Class 4, and molybdenum metal powder to Class 5.

The Ministry of Munitions has forwarded to all controlled establishments in the United Kingdom a set of rules for the guidance of employers and men. The rules lay down that every person employed in the establishment shall attend regularly and work diligently during working hours, and al o, if required, put in a reasonable amount of overtime, including week-end work unless holidays or sickness intervenes. There is to be no insistence on the observing of any rule, practice, or custom tending to restrict the rate of production, and various regulations are made under the heading of "Sobriety and Good Order." Breach of any of the rules involves a fine, on conviction before a Munitions Tribunal, not exceeding £3 for each offence.

At a meeting of the Newcastle and Gateshead Chamber of Commerce, Mr. H. Peile submitted a first report on behalf of the Steel Committee. The members were doing whatever they could in preventing the export of alloy steels and of insuring that nothing that the Government wanted should find its way abroad. Up-to-date, 78 licences for export had been issued, but one or two applications had been provisionally declined. It was not thought there was anything serious associated with these applications, but there were points for investigation. The fee had been fixed by the Admiralty at £9 12s. He was afraid it would hardly cover expenses. A large proportion of the certificates had been issued on the day they were applied for.

On September 28 the King paid a visit to Sheffield and inspected the Applied Science Department of the University in addition to which he visited a number of the steelworks in the locality. His Majesty was received by the Pro-Chancellor (Dr. George Franklin), who presented the Vice-Chancellor (Mr. H. A. L. Fisher) and the Registrar (Mr. W. M. Gibbons). The Lord Mayor presented Colonel Hughes, C.B., C.M.G. (chairman of the Sheffield Munitions Committee), the Master Cutler (Mr. W. H. Ellis), Alderman Hobson (treasurer of the Committee), Professor W. Ripper (vice-chairman), Messrs. Leonard B. Dixon, David Flather, Fred M. Osborn, Walter Tyzack, Albert Davidson (secretary), Alfred E. Wells, William Dyson, and John Baker (Rotherham board of management).

The appeal by William Beardmore & Company, Limited, against the City Assessor's valuation of their works at Parkhead has been further considered by the Glasgow Burgh Valuation Committee. At a previous sitting the case was continued in order that arrangements might be made for a visit being paid to the works and for the production of certain documents. An agreement has now been come to with regard to the works in Duke Street, the valuation of which the Assessor sought to have increased from £13,000 to £20,000. In terms of the decision the entry on the valuation roll will remain for this year at £13,000, and an undertaking was given by the agent for the appellants that within three months he would supply certain information asked for by the Assessor. Two other appeals by Messrs. Beardmore were adjourned till a subsequent sitting.

THE METROPOLITAN MUNITIONS COMMITTEE has opened offices at Alexandra House, Kingsway, W.C., under the general managership of Mr. Cecil Partridge. Mr. Ireland is the chief engineer. The Metropolitan area has been divided into 10 districts, under district managers, as follows:—Northern, Mr. A. Hugh Seabrook (acting), 62, Finsbury Pavement, E.C. (temporary address); North-western, Mr. E. T. Ruthven Murray, 346, High Road, Kilburn, N.W.; Southern, Mr. A. C. Cramb, Town Hall, Croydon; South-eastern, Mr. W. G. Head, Borough Hall, Royal Hill, Greenwich, S.E.; South-western, Mr. C. O. Grimshaw, 6, Eccleston Place, S.W.; Eastern, Mr. C. Newton Russell, 215 to 217, Bishopsgate, E.C.; East Central and part South-eastern, Mr. L. Harlow, 64, Bankside, S.E.; Western, Mr. R. S. Downe, Carnegie Library, Hammersmith, W.; Poplar and Stepney, Mr. G. M. Gill, East London College, Mile End, E. (temporary address); Outer Eastern, Mr. S. H. Wood, Gasworks, Beckton.

DISTINCTION was given to the re-opening of the Staffordshire County Metallurgical Institute at Wednesbury recently by the visit of Professor Hermann Hubert, of Liége University. This Institute, of which Mr. Walter Macfarlane, F.I.C., is president, was provided two years ago as an extension of a smaller one, and has been found of the greatest use to the iron and steel and other metallurgical industries which have their centre in Wednesbury. Mr. A. E. Pritchard, J.P., presided, and Professor Hubert distributed the prizes. Mr. Macfarlane read a long list of appointments secured by old boys and students, and mentioned that several had gained commissions and were serving at the front. A presentation of a group photograph of 120 old boys was made to Mr. Slater, as representing the Education Committee. Professor Hubert delivered an address on "The Conquest of Energy by Man." He described himself as a son of Liége, a district which had much in common with Staffordshire, while Liége itself was regarded as the Birmingham of Belgium.

THE BRITISH LABORATORY WARE ASSOCIATION, LIMITED, has been formed to stimulate the production, in this country, of a large number of laboratory requisites hitherto produced mainly in Germany and Bohemia. The firms in this association include:—Belcher (Standley) & Mason, Limited, Philip, Harris & Company, Limited, Southall Bros. & Barclay, Limited, Harrison, Parkinson & Company, Ferris & Company, Limited, A. H. Baird, Baird & Tatlock, Limited, Reynold & Branson, Limited, F. E. Becker & Company (W. & J. George, Limited, Successors, 1897), A. Gallenkamp & Company, Limited, John J. Griffin & Sons, Limited, Townson & Mercer, Limited, Fredk. Jackson & Company, Limited, James Woolley, Sons & Company, Limited, Brady & Martin, Limited, J. Preston, and J. W. Towers & Company, Limited. By concentrating orders the association has been enabled to induce various manufacturers to put down the necessary new plant to produce at reasonable prices. Respecting glass beakers, flasks, etc., the association has fixed standard sizes and made the necessary moulds.

IT is officially announced by the Ministry of Munitions that the Munitions Inventions Branch, which was recently constituted to deal with projects for inventions relating to munitions for warfare on land, or matters appertaining thereto, has now been removed from Armament Buildings, Whitehall, to accessible and commodious quarters in Princes Street, Storey's Gate, S.W. (hitherto the premises of the Whitehall Club), to which all future communications should be addressed. The department is now in working order, and is already dealing with a large number of proposals. The comptroller, Mr. E. W. Moir, is being assisted in this work by an advisory panel of scientific experts, whose names were announced on August 12. This body is now at work in committees, and every proposal receives consideration from them. While the comptroller is open to receive suggestions of all kinds falling within the category named, inventors and others should understand that it is undesirable to send forward their inventions until they have been well thought out. In this respect it is desirable for them to ascertain so far as possible, from Patent Office records and published sources, what has already been done in the direction of their particular inventions. All communications are confidential, and do not prevent a patent being subsequently taken out should the inventor so desire, or should the department think fit.

Parliamentary Notes.

Civil Engineers and Commissions.

ON September 21 MR. WATT asked whether an application was made in July by Mr. Tennant's Department to the Institute of Civil Engineers, to procure for them officers for the Royal Engineers who had a knowledge of heavy construction work. MR. TENNANT stated that the facts were substantially accurate. The result had been that 19 gentlemen had already received commissions in the R.E., and the consideration of the qualifications of others was proceeding, with a view to the filling of further vacancies which might occur.

Messrs. Merton and the Admiralty.

MR. R. PEARCE having asked the Secretary to the Admiralty whether Henry R. Merton & Company, Limited, were still employed by the Admiralty as metal brokers, having regard to the facts alleged by the Solicitor-General on September 17, in the case before the Admiralty Prize Court, and if so, whether such employment would cease, and when, MR. MACNAMARA has written in reply that the answer is in the negative.

Depreciation of Machinery.

MR. MELD asked the Chancellor of the Exchequer, on September 28, whether the allowance for depreciation under income-tax assessment would be increased, in view of the addition to the tax on the manufacturing community, among whom there was a consensus of opinion that the present 5 per cent. allowance was inadequate in view of the rapidity with which modern machinery called for replacement.

The CHANCELLOR OF THE EXCHEQUER replied as follows:—The rates of allowance for depreciation upon machinery, even in trades where a standard rate has been fixed by agreement with representative trade associations, are not rigidly fixed as suggested by the hon. member. The Commissioners of Taxes are empowered to make such deduction as they may think just and reasonable according to the circumstances of each individual case.

Association of German Iron and Steel Masters.

IN the House of Commons on September 23, SIR L. CHIOZZA MONEY asked the President of the Board of Trade whether, seeing that the German steel output was reported to have increased from 963,000 tons in January to 1,012,000 tons in April, he would say whether the Association of German Steel and Iron Masters have now returned the German steel output for July as 1,138,478 tons, and if he could give comparative figures for the British steel output.

The PRESIDENT OF THE BOARD OF TRADE replied that the figures of steel output published by the Association of German Iron and Steel Makers were as stated in the question of his hon. friend. He was unable to furnish monthly figures for the output of steel in the United Kingdom, and such current figures as were in the possession of his Department were not available for publication.

Deaths.

Mr. T. M. Birkett, brassfounder, Marsh Street, Hanley, died recently.

Mr. P. B. Grandison, secretary of Shanks & Company, Limited, Barrhead, died recently.

The death is reported of Mr. Robert Scott, the proprietor of the Winlaton Ironworks, near Newcastle, at the age of 55 years.

Mr. J. W. Goodman, brassfounder, of Oldham, died recently, at the age of 49 years.

The death is announced from Mulheim-am-Ruhr, at the age of 71 years, of Herr Josef Thyssen, one of the partners of the German steelmaking firm of that name.

Mr. Josiah Guest, J.P., head of the firm of J. Guest & Son, ironfounders, West Bromwich, has died suddenly at Bude, where he was spending a holiday to recuperate after an operation. Mr. Guest was 78 years of age.

Lieutenant A. W. Brydon, 2/4th Queen's (Royal West Surrey) Regiment, was killed in action at the Dardanelles on August 31. He was a director of Rhodes, Brydon & Company, Limited, engineers, of Gorsey Brow, Stockport, and was 31 years of age.

Mr. J. H. Whitburn, who for nearly half a century has been associated with Vivian & Sons, Limited, metal smelters, of Liverpool, and Swansea, has died suddenly. The deceased gentleman, who was 77 years of age, was a well-known figure in Liverpool and Birkenhead commercial circles.

Second-Lieutenant Raymond Lodge, the youngest son of Sir Oliver Lodge, has been killed while on service with the Mediterranean Expeditionary Force. He had taken up the profession of engineering, but on the outbreak of war he obtained a commission in the South Lancashire Regiment, and was attached to the 2nd Battalion at the time of his death.

Second-Lieutenant Thomas Wood Rutherford, who has been killed in the Dardanelles, was an engineer by profession. He served an apprenticeship with Richardson, Westgarth & Company, Limited, at Hartlepool. From there he proceeded to Glasgow University, and completing his studies, he was employed at Govan by Messrs. John McNeil & Company.

Mr. Joseph Hepworth, M.Inst.C.E., has died at his residence, 7, Priestfield Road, Edinburgh, at the age of 71 years. In early life he was at the Coventry Gas Works, and then became engineer of the Brighouse Gas Works. In 1870 he was appointed gas and water engineer at Carlisle, where he remained for 25 years. In 1895 he was elected one of the managing directors of W. & B. Cowan, Limited, Edinburgh, but continued his practice as a consulting gas and water engineer.

Mr. J. Sagar, a well-known Halifax engineer, died at his home, The Poplars, Halifax, on September 23, aged 62 years. For a long period he and his brother, the late Mr. Donald Sagar, carried on business as engineers at Halifax, and when the concern was formed into a company under the style of Messrs. J. Sagar & Company, Limited, he became the chairman, a position he has held since. He was an ex-president of the Halifax Engineering Employers' Federation, and a member of the Halifax Munitions Committee.

We regret to announce the death of Mr. Carl Holmstrom, a Swedish gentleman who was well known and respected in iron, steel and engineering circles in Great Britain. The deceased was born in 1861, and came over to this country about the year 1886 to enter the drawing office at the Nordenfelt works, which works were subsequently acquired by the firm now known as Vickers, Limited. In 1895 he went out to China for five years as a representative of Vickers, Sons & Maxim, Limited, and while there the Boxer rising in 1900 occurred, after which he returned to England. In 1901 he became associated with Wm. Beardmore & Company, Limited, Glasgow, and after being with that firm for about four years he joined John Brown & Company, Limited, as assistant manager of their Ordnance Department, which position he held at the time of his death.

The sudden death is announced of Mr. H. MacColl, a member of the engineering firm of MacColl & Pollock, Limited, Wreath Quay Works, Sunderland. The deceased spent his early days at Glasgow, and started an engineering business at Sunderland about 1895. Later Mr. Pollock became his partner, and under them the works have greatly developed. He served his apprenticeship at Glasgow with Messrs. Howden & Company. From there he went to Messrs. Harland & Wolf, Belfast, and eventually to the Central Marine Engineering Works, Hartlepool. Later he served seven years at Seville, Spain, as manager of an engineering works, and returned to England in 1895. He was a member of the North-East Coast Institute of Engineers, and of the Institute of Naval Architects.

Personal.

Mr. L. P. Sidney, assistant secretary of the Iron and Steel Institute, has been appointed to a position at the Ministry of Munitions.

The late Mr. J. S. White, a director of J. S. White & Company, Limited, left estate valued at £324,201 gross, with net personalty £316,342.

The late Mr. G. G. Moncur, of Mackenzie and Moncur, Limited, engineers, of Edinburgh and Glasgow, left estate of the gross value of £44,436.

The late Mr. William Jackson, engineer, of Aberdeen, largely interested in Marshall, Sons, & Company, Limited, Britannia Iron Works, Gainsborough, left estate valued at £77,052 gross.

The late Mr. A. Mitchell, superintendent of plant to the North British Locomotive Company, Limited, Glasgow, who died on May 2 last, aged 69 years, left personal estate in the United Kingdom valued at £9,137.

Estate valued at £10,703 has been left by the late Richard Clayton, of Coseley Hall, Staffs., managing director of the Cannon Iron Foundries, Limited, Deepfields, near Bilston. The net personalty amounted to £10,328.

The list of officers of the Iron and Steel Institute now includes as honorary vice-president Prof. D. Tschernoff, whilst Colonel W. Charles Wright and Mons. Gustave Trasenster have been elected members of council.

Mr. J. D. Connor has been appointed by the South Australian Government to inquire into the treatment of low-grade copper ores, and will visit the chief copper centres in America with a view of studying the latest practice there.

The officials and foremen of Sir W. G. Armstrong, Whitworth & Company, Limited, have presented a testimonial to Mr. E. Waggott, the manager of the Shell Department, Scotswood Works, Newcastle, on the completion of 27 years' service with the Elswick firm, and to mark the occasion of his silver wedding.

Sir H. F. Donaldson, the Chief Superintendent of Ordnance Factories (an appointment which includes the superintendency of Woolwich Arsenal), has left the Arsenal to take up work of greater urgency at the Ministry of Munitions. He will be succeeded at Woolwich by Mr. Vincent L. Raven, chief engineer of the North-Eastern Railway, who has recently been serving at the Ministry of Munitions. It is understood that Sir Frederick Donaldson's new appointment is really in the nature of a transfer for "the duration of the war," and that he will eventually return to his old post of control at the national arsenal. The new superintendent was appointed the chief engineer of the North-Eastern Railway in 1910, having been right through the shops as a pupil. Mr. Raven is a member of the Institution of Civil Engineers, the Institution of Mechanical Engineers, and the Iron and Steel Institute.

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New Companies.

Langham Steel Company, Limited.—Capital £5,000 in £1 shares.

Caton Engineering Company, Limited.—Capital £300,000 in £1 shares.

Strong Steel and Chemicals, Limited.—Capital £2,000 in 40,000 1s. shares.

Tool Makers and Light Machinery, Limited.—Capital £15,000 in £1 shares.

Duncan Stevens, Limited.—Capital £500 in £1 shares, to carry on the business of engineers, etc.

Walter & Frank Brown, Limited.—Capital £10,000 in £1 shares, to carry on the business of ironmasters, etc.

Tamar Wolfram Syndicate, Limited.—Capital £60 in 1s. shares, to adopt an agreement with J. G. Hawkey-Shepherd.

British Ropeway Engineering Company, Limited.—Capital £10,000 in £1 shares. Registered office: 31, Fenchurch Street, E.C.

Drogheda Ironworks Company, Limited.—Capital £1,500 in £1 shares. Registered Office: South Quay, Drogheda, Co. Louth.

Stacey Street Engineering Works, Limited.—Capital £500 in £1 shares. The first directors are: F. R. Ram and C. B. Young.

London Tin Smelting Company, Limited.—Capital £30,000 in £1 shares, to adopt an agreement with the Thames Metal Company, Limited.

Coventry Aluminium & Refining Company, Limited.—Capital £1,000 in £1 shares, to carry on the business of engineers, etc. Registered office: Nelson Street, Coventry.

Grant, Legros & Company, Limited.—Capital £20,000 in £1 shares, to carry on the business of ironfounders. Registered office: 78, Avenue Chambers, Southampton Row, W.C.

Whitfield Manufacturing Company, Limited.—Capital £5,000 in £1 shares (1,000 cumulative preference), to carry on the business of manufacturers of munitions. Registered office, 143, Charing Cross Road, W.C.

Shutt & Ganderton, Limited.—Capital £3,000 in £1 shares, to take over as from December 31, 1914, the business of a malleable ironfounder, carried on by T. H. Ganderton, as Shutt & Ganderton, at 138, Suffolk Street, Birmingham.

Overseas Engineering Company, Limited.—Capital £2,000 in £1 shares, to adopt agreements (1) with W. B. Shirehampton, A. S. F. Morris and F. J. Gordon. Registered office: 75, Curtain Road, E.C.

Montgomery Smith & Company, Limited.—Capital £10,000 in 9,950 ordinary shares of £1 each and 1,000 founders' shares of 1s. each, to take over the business of engineers carried on by Montgomery Smith & Company at Keynsham, Somerset. Registered office: Keynsham, Somerset.

The Arundel Smelting Company, Limited.—Capital £2,000 in £1 shares, to take over the business of smelters, refiners, and metal dealers carried on at Denby Street and Arley Street, Sheffield, as the Arundel Smelting Company. The first directors are E. N. Horton and S. Walton.

A. Hamilton & Sons, Limited.—Capital £5,500 in £1 shares, to carry on at Cardiff or elsewhere the business of ironmasters and contractors, iron, brass and other metal founders, etc., and to purchase the goodwill of the business of A. Hamilton & Sons. The first directors are: A. Hamilton, sen. (general manager), R. Hamilton, and A. Hamilton, jun.

West Bromwich Munitions Company, Limited.—Capital £100 in £1 shares. The first directors are S. A. Hill, E. L. Jacobs and G. H. Whitehouse, nominees of John Tickle & Company, Limited; Hedley's, Limited; and G. H. Whitehouse & Company, Limited. Registered offices: 77, John Street, West Bromwich.

H. E. C. Robinson & Company, Limited.—Capital £10,000 in £1 shares, to carry on the business of manufacturers of and dealers in ships, boats, fittings and boat disengaging gear, ironfounders, etc., and to take over the undertaking of H. E. C. Robinson & Company, incorporated in 1907, and now in liquidation. Registered office: 7, Strand-on-the-Green, Chiswick.

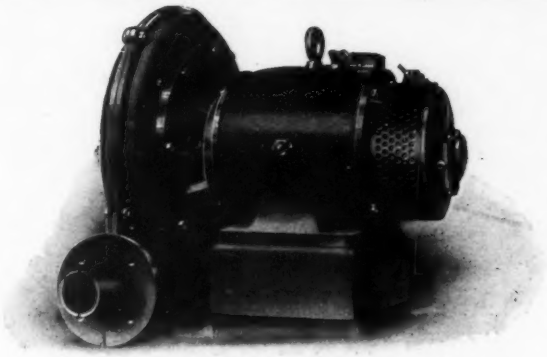
Spring Bank Iron Company, Limited.—Capital £20,000 (200 6 per cent. cumulative preferred and 200 ordinary shares of £50), to carry on the business of manufacturers of and dealers in iron, steel and other metals and hardware, etc., and to adopt an agreement with A. H. Shenton. Registered Offices: Spring Vale Street, Willenhall, Staffs.

Banks, Warner & Company, Limited.—Capital £5,000 in 4,550 preference shares of £1 each and 1,800 founders' shares of 5s. each, to take over the business of engineers carried on by Smith & Johnson at 11, Queen Victoria Street, E.C., and the business of insurance brokers carried on by Banks, Warner & Company at the same address. The first directors are F. Banks Warner, P. H. Smith, L. W. Johnson and D. Warner. Registered office: Mansion House Chambers, Queen Victoria Street, E.C.

Carnforth Hematite Iron Company (1915), Limited. Capital £144,000 in £1 shares (72,000 6 per cent. non-cumulative preference), to adopt an agreement with the Imperial and Foreign Corporation, Limited, to take over the undertaking carried on by the Carnforth Hematite Iron Company, Limited, or any portion or portions thereof, and to carry on the business of makers and manufacturers of and dealers in hematite, malleable and other iron and steel, etc. The first directors (to number not less than two nor more than eight) are Lieut.-Colonel W. T. Galloway and H. E. Carter.

Electrode Company of Sheffield, Limited.—Capital £40,000 in £1 shares, to manufacture and deal in carbon and other electrodes used in connection with electric furnaces and other materials and appliances for the manufacture of steel and alloys. The following are the first directors, nominated by the firms whose names are given in parenthesis:—D. Vickers and W. Clarke (Vickers, Limited); H. Peile (Newcastle Alloy Company); W. H. Ellis (John Brown & Company, Limited); F. C. Fairholme (Thomas Firth & Sons, Limited); I. B. Milne (Hadfields, Limited); C. W. Kayser (Kayser, Ellison & Company, Limited, and Samuel Osborne & Company, Limited).

Institute of Industry (of Great Britain and Ireland), Limited.—Registered as a company limited by guarantee with an unlimited number of members, each liable for £5 in the event of winding up, to promote, increase, and develop the industrial, scientific, financial, and commercial activity of the United Kingdom of Great Britain and Ireland and His Majesty's Overseas Dominions, Colonies, Dependencies, and Possessions, and generally to further and encourage inter-Imperial trade throughout the British Empire. The first directors are:—Sir H. H. Bartlett, Bart., 56, Victoria Street, Westminster; Sir William Beardmore, Bart. (W. Beardmore & Company, Limited), Glasgow; Sir Clifford Cory, Bart., 98, Mount Street, W.; Mr. Arthur du Cros, J.P., M.P., 14, Regent Street, W.; Mr. L. Evans, Russell, near Watford, Herts.; Sir James Heath, Bart., Oxenden Hall, Market Harborough; Mr. G. B. Hunter, The Willows, Clayton Road, Newcastle-on-Tyne; Mr. G. Johnson (the Rolls-Royce Company, Limited), Conduit Street, W.; Mr. J. W. Macdonald; Mr. W. J. Noble; Mr. J. Taylor Peddie, 39, Murray Road, Wimbledon, S.W.; Sir Adolph Tuck, Bart.; Mr. J. Turner (Messrs. Read, Holliday & Sons, Limited), Huddersfield; Sir William G. Watson, Bart.; Mr. G. A. Wills; Mr. G. McLaren Brown; Mr. W. Deakin, Thornleigh, Oakfields Road, Selly Park, Birmingham, engineer; Mr. S. R. Illingworth, Fern Villa, Chesham Bois, Bucks.; Mr. T. C. Moore, Shelton, Stoke-on-Trent; and Mr. A. Home-Morton, 2, Eldon Street, E.C., consulting engineer. Registered office: Exhibition Buildings, Aldwych Site, Strand, W.C.



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Paisley, 12th March, 1909.

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Inventions.

Applications for Patents.

An asterisk indicates that a complete specification accompanies the application. When inventions are communicated the names of the communicators are in brackets.

11,793. Furnaces. R. H. Anderson.
11,818.*Electrolytic refining of tin. (American Smelting & Refining Company, United States.)
11,820. Production of aluminium. E. de St. Laurent.
11,862. Extraction of zinc from its ores. H. L. Sulman and Metals Extraction Corporation, Limited.
12,023. Furnace fronts. J. Howden & Company, Limited.
12,047.*Ingot mould with vacuum chamber. J. I. Peyton and S. E. Hitt.
12,137.*Process and apparatus for the recovery of metals from their ores. Koering Cyaniding Process Company, and B. R. Koering.
12,304.*Moulding-machine with multiple compression device. A. Utard.
12,327. Manufacture of hollow castings. A. P. Smith.
12,356.*Tire mould cores. J. H. Coffey and J. H. Coffey, Jun.
12,358.*Process for desulphurising, reducing, and refining nickel ores. L. P. Burrows.
12,491. Sand-moulding machines. R. A. Blakeborough and W. Boyd.
12,606.*Heating-apparatus for heating metal tyres and other metal objects. T. Flanagan.
12,708. Mechanical roasting furnaces. A. Zavelberg.
12,907. Manufacture of hollow castings. A. P. Smith.
12,993. Apparatus for determining the "critical" or "conversion" point of samples of iron or steel by measuring the electrical resistance of a test piece of such metal whilst heated to a high temperature. (Peter Saldaw, Russia.)

A NEW BEARING ALLOY.—An alloy containing about 97 per cent. lead, hardened without antimony, copper, or spelter has been brought out by the Lubricating Metal Company, New York, U.S.A., for use in general bearing work. Under a compression test of 13,000 lbs., a cylinder 1 in. in diameter and 1 in. long showed a permanent set of 0.0086 in. As a result of this and similar tests, an elastic limit of about 11,000 lbs. per sq. in. is claimed, or nearly twice that of genuine babbitt, which is around 6,500 lbs. per sq. in. It has an ultimate strength in compression of approximately 22,000 lbs. per sq. in. Tensile tests indicate an ultimate strength of from 13,000 to 15,600 lbs. per sq. in. As the composition is varied to raise the elastic limit, it is asserted that the effect is to lower the ultimate strength. This is exactly opposite to the results obtained in other classes of metals, according to the "Iron Age." The alloy is known as "Noheet," and it is claimed that it retains all the natural lubricating qualities of lead, and has a coefficient of friction about 25 per cent. less than that of other bearing metals. In the process of manufacture the hardening agent impregnates the metal with an alkaline substance, so that wherever it is used in pumps, water-jacketed bearings, or elsewhere coming in contact with water, a slight saponification is produced which further aids lubrication and reduces friction. The high tensile and compressive strength of the alloy, together with its low coefficient of friction, is given as a reason why it is adapted to use on high-speed machinery as well as heavy-duty work.

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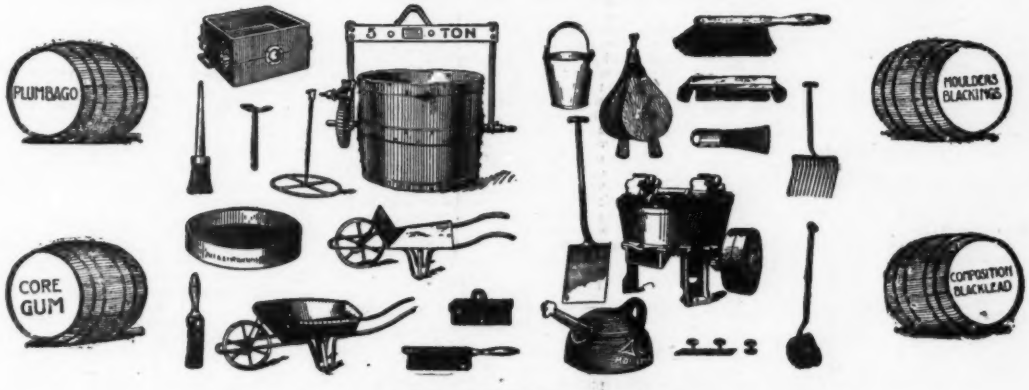
JAS. DURRANS & SONS,

Phœnix Works, Penistone, Near Sheffield.



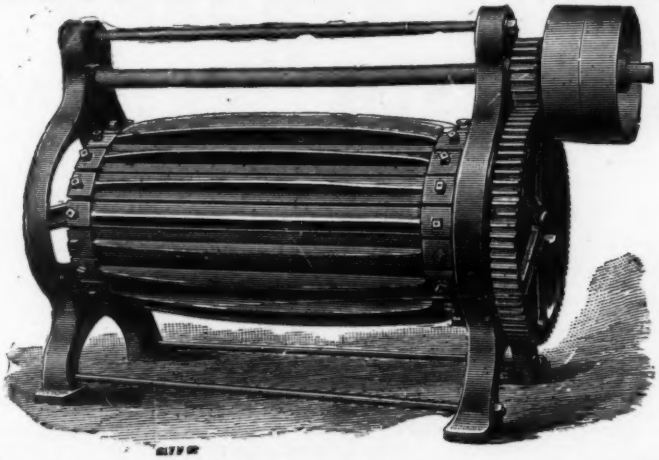
Manufacturers of all

FOUNDRY EQUIPMENTS

COMPOSITION BLACK LEAD, PLUMBAGO, CORE GUM, WHITE DUST & COAL DUST

Ladles, Cupolas, Fire Bricks, Gannister, Stone Flux, Loam and Sand Mills, Casting Cleaners, Studs, Chaplets, Pipe Nails, Sprigs, Brushes, Wire Brushes, Core Ropes, Bellows, Buckets, Spades, Forks, Riddles, Sieves, Barrows, Etc.

Improved Foundry Rattler or Fettling Drum.



These Machines are invaluable for a Foundry, doing a larger amount of work of a superior quality, in a much shorter time than can be done by hand, without skilled labour.

The following testimonial explains itself :—

"Dear Sirs,—We have been using your best Blacking for a large number of years, and always use it on our large Ingot Moulds, which, as you know, we have made up to 85 tons in weight.

Yours faithfully, THE BRIGHTSIDE FOUNDRY & ENGINEERING CO., LD.

MONTHLY PRICE LIST.

The undermentioned prices, unless otherwise specified, are those obtaining on the first day of the current month.

Pig-iron.

Cleveland.

	s.	d.
Cleveland No. 1	69	6
,, No. 3	65	6
,, No. 4 foundry	65	0
,, No. 4 forge	64	0
,, Mottled	63	6
,, White	63	6
East Coast hematite, mixed Nos. ..	111	0
Cleveland warrants	65	0

Above prices are for early f.o.b. deliveries and as regards Cleveland iron are for G.M.B. brands. The warrant quotations are the sellers cash prices.

Scotland.

	s.	d.
Standard Foundry (Glasgow Market settlement price)	64	4½
Warrants, ditto	70	9

Makers' prices:—	s.	d.		s.	d.
Gartsherrie No. 1..	85	0	No. 3..	80	0
Coltness No. 1..	102	0	No 3..	82	0
Summerlee No. 1..	85	0	No. 3..	80	0
Langloan No. 1..	85	0	No. 3..	80	0
Calder No. 1..	80	0	No. 3..	75	0
Clyde No. 1..	86	0	No. 3..	81	0
Carnbroe No. 1..	83	0	No. 3..	79	0
Monkland No. 1..	81	0	No. 3..	79	6
Shotts No. 1..	85	0	No. 3..	80	0
Govan No. 1..	75	6	No. 3..	74	6

(All deliverable alongside Glasgow.)

Glengarnock	No. 1	86	0	No. 3..	81	0

(Deliverable alongside Ardrossan.)

Dalmellington	No. 1	82	0	No. 3..	80	0
Eglinton	No. 1..	79	0	No. 3..	78	0

(Deliverable alongside Ayr.)

Carron	No. 1..	86	0	No. 3..	81	0

(F.a.s. Grangemouth.)

Lancashire.

	s.	d.	s.	d.
Lancashire No 3 foundry f.o.t.	—		—	
Lincolnshire No. 3 foundry ..	—		72	9
Derbyshire No. 3 foundry ..	71	0	71	6
Staffordshire No. 3 foundry ..	—		71	0
Cleveland No. 3 foundry ..	—		73	2

(All delivered equal Manchester.)

Scotch No. 3	Gartsherrie	—		86	0
	Glengarnock	84	6	87	0
	Eglinton	—		Nom.	
	Summerlee	85	0	86	0

(Delivered Manchester Docks.)

North-West of England.

	s.	d.	s.	d.
Bessemer mixed numbers net f.o.b.	105	9	107	6
Hematite warrant net cash ..	—		95	0
Lorn cold-blast charcoal iron ..	—		—	

The Midlands.

		s.	d.	s.	d.
Staffs.	Common forge ..	65	0	—	
	Part Mine forge ..	67	0	68	0
	Best All Mine ..	—		130	0
	Cold Blast	—		150	0

Strong forge, about 1s. less than grey forge; Mottled and White, about 2s. less than forge; Foundry No. 3, 3s. to 5s. above forge; No. 1 and No. 2, from 1s. 6d. to 2s. above No. 3; No. 1, about 2s. above No. 2.

Northampton foundry	—	—
North Staffs. foundry	—	—
Derby foundry	—	—
Nottinghamshire foundry	—	—
Leicestershire foundry	—	73 0
Shropshire Cold-Blast	—	—

Delivered South Staffordshire Works, net cash monthly.)

Lincolnshire.

	s.	d.	s.	d.
Forge	—		—	
Grey forge..	—		—	
Basic	—		—	
No. 3 foundry	—		—	
No. 4 foundry	—		—	

F.o.t. Makers' works.

South Wales.

	s.	d.	s.	d.
Welsh Hematite	—		100	0

Ferro-Alloys.

Net, Delivered Sheffield Steel works.

	£	s.	d.
Ferro-chrome: 4/6% carbon. Basis 60%, scale 10s. per unit. Per ton	32	0	0
Ferro-chrome: 6/8% carbon. Basis 60%, scale 10s. per unit. Per ton	29	10	0
Ferro-chrome: 8/10% carbon. Basis 60%, scale 8s. 6d. per unit. Per ton	28	0	0
Ferro-chrome: Specially refined, guaranteed maximum 2% carbon, broken to small pieces for use in best quality crucible steels. Basis 60%, scale 22s. per unit. Per ton	80	0	0
Ferro-vanadium: 33/40% Va., per lb. of Va. contained in the alloy ..	0	9	6
Ferro-silicon: 45/50%. Basis 50%, 5s. scale per unit .. Per ton	19	10	0
Ferro-titanium: 23/25%, per pound, carbonless	0	1	6
Ferro-molybdenum: 70/80% Mo. per pound of Mo. contained	0	18	0
Ferro-phosphorus: 20/25%. Per ton	16	10	0
*Ferro-manganese 80%	20	0	0
,, export	—		

* F.o.b. Liverpool.

Iron Castings.

Cleveland.

	£	s.	d.		£	s.	d.
Columns (plain)	7	7	6	to	7	12	6
Pipes, 1¼ to 2¼ in. ..	7	5	0		7	15	0
,, 3 to 4 in. ..	6	12	6		6	17	6
,, 5 to 8 in. ..	6	7	6		6	10	0
,, 10 to 16 in. ..	6	7	6		—		
,, 18 to 24 in. ..	6	7	6		—		
Chairs	4	7	6		4	10	0
Floor plates (oper. sand)	3	10	0		3	12	6

(At work).

Non-Ferrous Metals.

Copper.	£	s.	d.	£	s.	d.
Standard, Cash ..	72	2	6	72	7	6
Three months ..	73	2	6	73	7	6
Electrolytic	87	10	0	88	10	0
Tough	84	0	0	85	0	0
Best selected	84	0	0	85	0	0

Tin.						
Standard, Cash ..	148	5	0	148	15	0
,, Three months	149	15	0	150	5	0
English Ingots ..	—			148	10	0
Bars	—			149	10	0
Refined	—			153	0	0

Spelter.						
American	—			71	0	0
Specials	—			—		
Hard	—			50	0	0
British	72	0	0	73	0	0

Lead.						
Soft foreign	—			24	10	0
English	—			25	0	0

Antimony.						
Regulus	—			100	0	0

Aluminium.						
Virgin Metal 98/99% .. per ton				185	0	0

*Chromium (Metallic).						
98/99% purity per lb. ..				—		

*Nickel.						
In cubes, 98/99% purity Per ton				220	0	0

*Tungsten Metal Powder.						
96/98% purity .. per lb. ..				0	5	10

*Molybdenum Metal.						
96/98% purity.. per lb. ..				—		

*Cobalt Metal.						
97% purity .. per lb. ..				0	8	0

Quicksilver.						
75 lb. bottle				15	18	9

* Net, Delivered Sheffield Works.

Scrap Iron and Steel.

Cleveland.

	s.	d.		s.	d.
Steel scrap, heavy melting ..	68	9	to	71	3
Iron scrap cast (cupola metal)	55	0		56	0

London (f.o.b.).

Heavy steel	60	0	
Light ,, ...	50	0	
Heavy cast	60	0	

Non-Ferrous Scrap.

London merchants quote the following prices for scrap metal, delivered London, and subject to market fluctuations: —

	A. Joseph. £	s.	d.
Hy. Electrolytic Copper Scrap ..	—		
Hy. Selected Scrap Brass	—		
Hy. Tinned Copper Wire	—		
Best Selected Gunmetal Scrap	—		
Re-melted Ingot Lead 30s. under English Lead price on date of order.			

Stocks.

Pig-Iron in Public Store.

	Oct. 4. Tons.	Inc. + or Dec. — since Oct. 7, 1914. Tons.
Connal's at Glasgow Scotch	1,000	No change
Ditto other makes ..	—	No change
Connal's at Middlesbrough	139,677	+ 33,834
Connal's at Middlesbrough, hematite ..	—	No change.
West Coast hematite..	2,120	— 928

Metals.

Copper, Europe and afloat	34,106	— 488
Tin, London, Holland, U.S.A. and afloat ..	17,286	+ 192

Coke.

Middlesbrough.

	s.	d.		s.	d.
Gas Coke	—			27	0
Foundry Coke	32	6	to	35	0
Furnace coke	—			24	0

Newcastle-on-Tyne.

FOUNDRY COKE—	F.o.b. s.	d.	Dunston s.	d.
Original Garesfield ..	—		32	0
Mickley	—		32	0
Stella Garesfield ..	—		32	0
Priestman's Garesfield	32	0	33	0
Consett Garesfield ..	32	0	33	0
Newcastle gas coke ..	—		29	0

Cardiff.

	s.	d.		s.	d.
Special foundry coke ..	40	0	to	42	6
Foundry coke	34	0	to	38	0
Furnace coke	28	0	to	32	0

Leeds.

Furnace coke (washed) ..	—	15 0

Birmingham.

Foundry coke	—	—
Furnace ,, ...	—	—
Gas ,, ...	18 0	22 6

Glasgow.

Foundry coke	—	30 0
Furnace ,, ...	—	24 0
Gas ,, ...	—	—

London.

Welsh or Durham Foundry, d/d London Stations, in truck	—	45 6
Yorkshire, d/d London Stations, in truck ..	—	32 0

SITUATIONS VACANT AND WANTED.

PARTNER (Active if Desired), with £600, required by well-equipped and well-connected Iron Foundry in the Midlands.—Apply, Box No. 590, Offices, FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

BELGIAN MANUFACTURER requires representative, well introduced in the Iron Foundries, for the sale of First-Class Iron Cement.—Write, H. W. R., Noord-Besterdstraat, 78, Tilburg, Holland.

PATENTS.

THE Owner of Patent No. 17,021/11, for "Improvements in or relating to the Production of Castings of various kinds and means or Apparatus therefore," is desirous of negociating with interested parties for the granting of Licences thereunder on reasonable terms.

For information apply to Messrs. LLOYD, WISE & Co., Chartered Patent Agents and Consulting Engineers, No 10, New Court, Lincoln's Inn, London, W.C.

HERBERT HADDAN & CO., Chartered Patent Agents, of 31 & 32, Bedford Street, Strand, London, W.C., beg to call the attention of engineers, manufacturers, and others, to the following important ENGLISH PATENTS, the proprietors of which are desirous of arranging by licence or otherwise, on reasonable terms, for the manufacture and commercial development of the inventions in this country.

Improvements in Foundry Machines, No. 5,832/13.

Improvements in or Relating to Foundry Moulding Machines, No. 25,428/12.

For particulars mentioning number and year of the patents, address HERBERT HADDAN & Co., Chartered Patent Agents, as above.

FOR SALE.

GOOD Massey Overhang type 3 cwt. Steam Hammer, 7 in. cylinder by 15 in. stroke, rod 3¼ diameter, with loose anvil block and stand, in good condition.—MARPLE & GILLOTT, LIMITED, Sheffield.

COMBINED Mortar Mill, Engine, and Boiler, 7 ft. pan; ditto, with 6 ft. pan.—JOSEPH PUGSLEY, Cattybrook Ironworks, Lawrence Hill, Bristol.

TO BRASS FOUNDERS AND OTHERS.—For Sale, almost new, One No. 2 "Economic" Coke-Fired Crucible Melting Furnace, tipping type, complete with Y-shaped blast pipe. Firebrick lining to take a 250-lb. crucible. Also motor stand for same, fan and starter. Very cheap.—Apply, Box 582, Office FOUNDRY TRADE JOURNAL, 165, Strand, London, W.C.

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MAKING INTRICATE CASTINGS

FOR THE GOVERNMENT

In Aluminium & Bronze

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CHATTERIS - - ENGLAND.

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CYLINDERS, CHILLED CASTINGS,
MACHINE CASTINGS, and any
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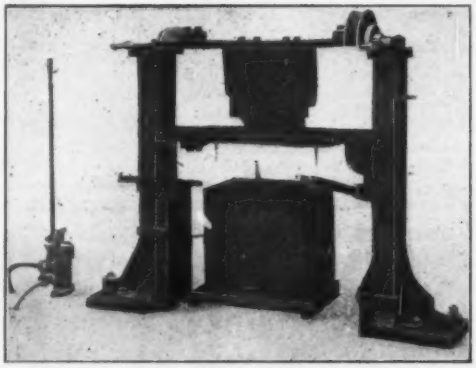
THE "CHIPCHASE" PATENT

MOULDING MACHINE.

(HYDRAULIC or PNEUMATIC)

SIMPLE - STRONG - DURABLE



This illustration shows the 3rd position in the making of axle boxes.

THE "CHIPCHASE" PATENT JARRING MACHINE.

THE "CHIPCHASE" PATENT CORE MAKING MACHINE.

Sole Makers—

DAVID BRIDGE & Co., Ltd.,

CASTLETON FOUNDRY, CASTLETON, MANCHESTER.

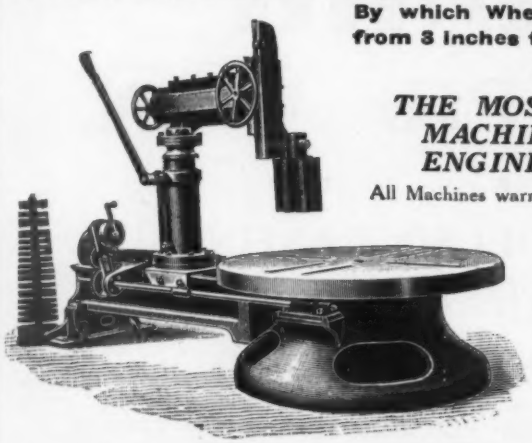
38¼"
McNEIL'S
PATENT UNBREAKABLE
STEEL LADLES
These Ladles are manufactured by a patented process, each from a single steel plate without weld or rivet. They are extremely light, being at the same time the strongest and most durable in the market. Ladles to contain 56 lb. of metal only weigh about 7 lb. each. They are made of all capacities from 30 lb. to 60 cwt., with or without lips; also mounted or unmounted. They are also suitable for chemical and metallurgical processes. List of sections and prices on application to
CHAS. McNEIL.
KINNING PARK IRONWORKS,
GLASGOW.
36"
32½"

CAN ALSO BE MADE IN ALUMINIUM.

Kindly mention this paper when enquiring or ordering.

WHITTAKER'S IMPROVED MOULDING MACHINE

By which Wheels or Pulleys of any description or size from 3 inches to upwards of 20 ft. diameter can be made.



THE MOST COMPLETE AND EFFICIENT MACHINE HITHERTO INTRODUCED TO ENGINEERS.

All Machines warranted to Mould with the greatest accuracy and precision.

GEARING WHEELS

Spur or Bevel, Straight Teeth and Double Helical Teeth Supplied to Consumers.

ROPE & BELT PULLEYS.

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